Instruction Manual

For Model Easy-Start ES Solid State Reduced Voltage Motor Starter

Cutler-Hammer

EATON

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Table of Contents

Page

Safety S-1
- The Meaning of Safety Statements S-2
- Easy-Start ES Safety Statements S-2

Introduction 1-1

Installation 2-1
- Pre-Installation 2-3
- Drawings 2-19
- Specifications 2-45

Operation 3-1
- Operation 3-2
- Adjustments 3-2
- DIP Switch Settings 3-3

Options 4-1
- Available Options 4-2
- Application Notes 4-13
- Drawings 4-21

Troubleshooting 5-1
- Troubleshooting Guide 5-2
- SCR Diagnostics Tests 5-5
- Renewal Parts List 5-13

List of Illustrations

Figure	Description	Page
2-1	Block Diagram	2-20
2-2	System Schematic (Hevi-Duty Co. - Multi Volt Transformer Connections)	2-21
2-3	System Schematic (Cutler-Hammer Transformer Connections)	2-22
2-4	Logic Board Terminal Block TB1 Functions	2-23
2-5	Derate Curve For Altitude	2-24
2-6	Momentary Contact Start/Stop Pushbuttons	2-25
2-7	Hand-Off-Auto Selector Switch	2-26
2-8	Start-Stop Pushbuttons with Hand-Off-Auto Selector Switch	2-27
2-9	Power Connections with Options (Hevi-Duty Co. Multi Volt Transformer)	2-28
2-10	Power Connections with Options (Cutler-Hammer Transformer)	2-29
2-11	Dimension and Installation Open Panel ES045-_EP, ES070-_EP, ES120-_EP	2-30
2-12	Dimension and Installation Open Panel Slim Line Motor Control Center ES070-_EC	2-31
2-13	Dimension and Installation NEMA-12 Regular Enclosure ES045-_ER, ES070-_ER	2-32
2-14	Dimension and Installation NEMA-12 Large Enclosure ES045-_EL, ES070-_EL, ES120-_EL	2-33
2-15	Dimension and Installation Open Panel ES180-_NP, ES260-_NP, ES560-_NP, ES250-_EP, ES360-_EP, ES500-_EP	2-34
2-16	Dimension and Installation Open Panel Slim Line Motor Control Center ES120-_EC	2-35
2-17	Dimension and Installation Open Panel Slim Line Motor Control Center ES180-_NC, ES250-_NC	2-36

List of Illustrations

Figure	Description	Page
2-18	Dimension and Installation NEMA-1 Regular Enclosure ES180-_NR, ES260-_NR, ES560-_NR	2-37
2-19	Dimension and Installation NEMA-1 Large Enclosure, ES180-_NL, ES260-_NL, ES560-_NL	2-38
2-20	Dimension and Installation Open Panel ES750-_NP	2-39
2-21	Dimension and Installation NEMA-1 Large Enclosure ES750-_NL	2-40
2-22	Dimension and Installation NEMA-12 Large Enclosure ES250, ES360-_EL	2-41
2-23	Dimension and Installation NEMA-12 Large Enclosure ES500-_EL	2-42
2-24	Dimension and Installation NEMA1 ES950-_NL	2-43
2-25	Dimension and Installation Open Panel ES950-_NP	2-44
3-1	Over-Load Time-Current Characteristics	3-14
4-1	NEMA-1 Current Vs. Time Ratings	4-22
4-2	NEMA-12 Current Vs. Time Ratings	4-23
4-3	Extended Start Time with By-Pass Contactor	4-24
4-4	Option E1- Extended Start Time with Ramp-Up Door Light	4-25
4-5	Smooth Stop with By-Pass Contactor	4-26
4-6	Smooth Stop “S1” Option	4-27
4-7	Smooth Stop with Remote Maintained 2-Wire Contact	4-28
4-8	Jam DIP Switch Trip Point Settings	4-29
4-9	Jam Trip Time Curves	4-29
4-10	Underload DIP Switch Trip Point Settings	4-30
4-11	Underload Trip Time Curves	4-30
4-12	Options J1, J2 Jam-Underload with Red Trip Lights	4-31
4-13	Daughter Board Connections	4-32
4-14	Printed Circuit Logic Board Component Layout	4-33
4-15	Option E - Printed Circuit Board Component Layout - Extended Start Time	4-34
4-16	Option S - Printed Circuit Board Component Layout - Smooth-Stop	4-35
4-17	Option J - Printed Circuit Board Component Layout - Jam-Underload	4-36
4-18	Option U - Printed Cirucit Board Component Layout - Shorted SCR Detector	4-37
4-19	Option D - Printed Circuit Board Component Layout - Daughter Board	4-38
4-20	Dimension For Logic Board, Daughter Board, Cover Board Assembly	4-39
5-1	Typical SCR Clamp Used in ES180, ES260	5-7
5-2	Typical SCR Clamp Used In ES180, ES250, ES260: 1 Leaf ES360, ES500, ES560: 2 Leaves	5-7
5-3	Assembly Sink-Device Clamp	5-9
5-4	Stack Loading	5-10

List of Tables

Table	Description	Page
2-1	Starts-Per-Hour ES045	2-10
2-2	Starts-Per-Hour ES070	2-10
2-3	Starts-Per-Hour ES120	2-11
2-4	Starts-Per-Hour ES180	2-11
2-5	Starts-Per-Hour ES250	2-12
2-6	Starts-Per-Hour ES260	2-12
2-7	Starts-Per-Hour ES360	2-13
2-8	Starts-Per-Hour ES500	2-13
2-9	Starts-Per-Hour ES560	2-14
2-10	Starts-Per-Hour ES750	2-14
2-11	Starts-Per-Hour ES950	2-15
3-1	Dip Switch Setting Multipliers	3-3
3-2	Dip Switch Ampere Settings ES045	3-4
3-3	Dip Switch Ampere Settings ES070	3-5
3-4	Dip Switch Ampere Settings ES120	3-5
3-5	Dip Switch Ampere Settings ES180	3-6
3-6	Dip Switch Ampere Settings ES250	3-6
3-7	Dip Switch Ampere Settings ES260	3-7
3-8	Dip Switch Ampere Settings ES360	3-7
3-9	Dip Switch Ampere Settings ES500	3-8
3-10	Dip Switch Ampere Settings ES560	3-8
3-11	Dip Switch Ampere Settings ES750	3-9
3-12	Dip Switch Ampere Settings ES950	3-9
3-13	Voltage Plugs and Jumper Positions	3-10
4-1	Thermal-Magnetic Breaker	4-5
4-2	Magnetic Breaker	4-6
4-3	Circuit Breaker Interrupting Rating and Terminal Sizes	4-7
5-1	J4 Connector Test Voltages	5-12

Safety

Cutler-Hammer has made every effort to provide you with the safest motor starters on the market but wishes to point out how to safely operate and troubleshoot your starter.

After you review this section you will:

- Understand the meaning of the Safety Alert Symbol, Danger, Warning, Caution, and Notice safety statements.
- Know what safety statements you should be aware of when you operate and troubleshoot Cutler-Hammer motor starters.

Safety

The Meaning of Safety Statements

You will find various types of safety information on the following pages and on the labels attached to the equipment. This section explains their meaning.

The Safety Alert Symbol means ATTENTION! BECOME ALERT! YOUR SAFETY IS INVOLVED!

⚠ Danger

Danger means that failure to follow this safety statement ***will*** result in serious personal injury or death.

⚠ Warning

Warning means that failure to follow this safety statement ***could*** result in serious personal injury or death.

⚠ Caution

Caution means that failure to follow this safety statement ***may*** result in minor or moderate personal injury or property damage.

Notice - means that failure to follow these instructions could cause damage to the equipment or cause it to operate improperly.

Easy-Start ES Safety Statements

The following safety statements relate to the installation, operation and troubleshooting of Cutler-Hammer Motor Starters.

Notice - Make sure you read and understand the installation procedures in this manual ***before*** you attempt to operate or troubleshoot the equipment.

⚠ Danger High Voltage

Non-isolated heat sink frames are electrically hot when line voltage is connected, which may result in death or personal injury if touched. Do not touch heat sink frames unless line side power is disconnected and locked out.

⚠ Warning

This instruction manual should be used for proper installation, operation and maintenance of the equipment. Improperly installing and maintaining these products can result in death or serious personal injury. Before attempting installation or maintenance, read and understand all instructional materials related to the product. If further information is required, you should consult Cutler-Hammer Corporation.

Notice - Select proper voltage plug and install into socket J5 on the logic board.

⚠ Danger

Isolated heat sink frames must be grounded with the grounding lugs provided.

All electrical codes must be followed which may require additional conduit and enclosure grounding.

⚠ Danger High Voltage

There can be line voltage potential at the motor load terminals even with the starter in the off-state. This is due to the RC snubber network across the SCR's and leakage across SCR's.

Always disconnect input power before servicing starter or motor.

Notice - Power factor capacitors: Do not connect power factor correcting capacitors to the load side of the starter. They will cause the starter to fail. If capacitors are used they must be connected to the line side of the starter, at least 10 feet upstream of the starter.

⚠ Caution

Do not connect any additional control circuits, such as lamps and relays, across K2 coil (TB1-4 and TB1-12 on the logic board).

⚠ Caution

The fan control power transformer is pre-wired at the factory (refer to Section 2). Be sure to check compatibility to line voltage before applying line power to the Easy-Start.

SECTION 1
Introduction

About This Manual

Congratulations! You have purchased one of the most sophisticated Solid State Reduced Voltage Starters in the industry. Models are available from 45 to 950 Amp applications.

This manual provides a check list, drawings, specifications and pre-installation information, and the various available options to help you select the right equipment and properly install your Easy-Start ES Reduced Voltage Starter.

To assure successful installation, thoroughly read and understand the material presented in each section before you attempt to install the drive. If this is your first installation, we suggest that you read each section in the sequence they are presented since they assume you know the material presented previously. Once you are an experienced installer, you can use the manual as a source of reference.

Easy-Start ES Solid State Reduce Voltage Starters are designed to provide reduced voltage starting of three phase motors. The Easy-Start ES has standard features which can be adjusted to tailor your starter's performance to suit your needs.

Note that throughout the manual, titles of sections and specific parameters are shown in *italics*. Items in ***bold italics*** are important.

If you have any questions or comments, please feel free to contact us. We at Cutler-Hammer are proud to have you as a customer and can assure you that you will have many productive years from your new Easy-Start ES Solid State Reduced Voltage Starter.

SECTION 2
Installation

About This Section

This section of the Easy-Start ES Instruction manual provides pre-installation information, drawings and specifications to help you properly install your Easy-Start ES Solid State Reduced Voltage Starter.

To ensure successful installation, thoroughly read and understand the material presented in this section before you attempt to install the Starter. If this is your first installation, we suggest that you read these sections in the sequence they are presented. Once you are an experienced installer, you can use this section as a source of reference.

Pre-Installation

This part of the *Installation* section of this Instruction Manual provides guidelines to consider ***before you install your drive***:

- Description.
- Easy-Start ES Model Designation.
- Application Considerations.
- Considerations for Field Wiring.

Description

The Easy-Start ES solid state unit is a complete reduced voltage 3-phase AC motor starter with motor protection. It is available in basically 9 different sizes, NEMA-12/NEMA-1:

45 Amps	NEMA-12	
70 Amps	NEMA 12	Each size
120 Amps	NEMA-12	is rated
180 Amps	NEMA-1	for a
250/260 Amps	NEMA-12/NEMA-1	starting
360 Amps	NEMA 12	duty
500/560 Amps	NEMA-12/NEMA-1	for 20
750 Amps	NEMA-1	seconds.
950 Amps	NEMA-1	

There are 3 AC line voltage combinations for each size:

208/230/460V	50/60 Hz
380/415V	50/60 Hz
460/500/575V	50/60 Hz

This solid state starter incorporates 6 SCR's in the power section. It provides a soft-start for 3-phase induction motors either with voltage ramp, or current ramp mode, and with current limit over ride.

A built in energy saving circuit reduces the motor voltage and current at light loads, and saves power.

Block Diagram Description (Figure 2-1)
System Schematic (Figures 2-2 and 2-3)

The line current is sensed by using three ***current transformers***. These AC signals are converted to DC through a rectifier. Also, each phase current is signal conditioned to produce a DC signal for that phase or power line.

DIP switches are used to calibrate the current rating and match it to the motor name plate for these functions:

A. ***Current Feedback*** for energy saving load sensing.
B. Over-Current protection:
   1. ***Inverse-Time Trip***
   2. ***Instantaneous Trip***
C. ***Current Limit***

By using ***voltage feedback***, the Easy-Start ES senses the motor load and slip-speed and adjusts the motor voltage and current to conserve power whenever the motor is lightly loaded. Line voltage is also sensed in order to give motor voltage regulation; this is especially useful at high line voltages which could cause excess motor temperature rises.

Description

Sensing the line voltage provides important information for diagnostics and motor protection. The features include the following:

Phase Rotation Protection:
Inhibits starting of the motor unless rotation is A-B-C.

Phase Loss Protection:
Trips starter off line if one or more phases are lost.

Under-Voltage Protection:
Trips starter off line if line voltage drops below 75% of nominal rating.

The Easy-Start ES has a built-in ***adjustable ramp*** which can be used in either voltage mode or current mode. It also has an adjustable initial step which represents initial voltage or initial current depending on the position of the voltage/current ramp DIP switch "DS3-1." The ramp and initial step functions are in the circuit only in the start mode.

The ramp and voltage/current signals are fed into a main ***amplifier***. This amplifier is biased by an adjustment marked **MIN**. This adjustment is used to set the minimum motor voltage at no load. It is factory set to about 50% of nominal line voltage.

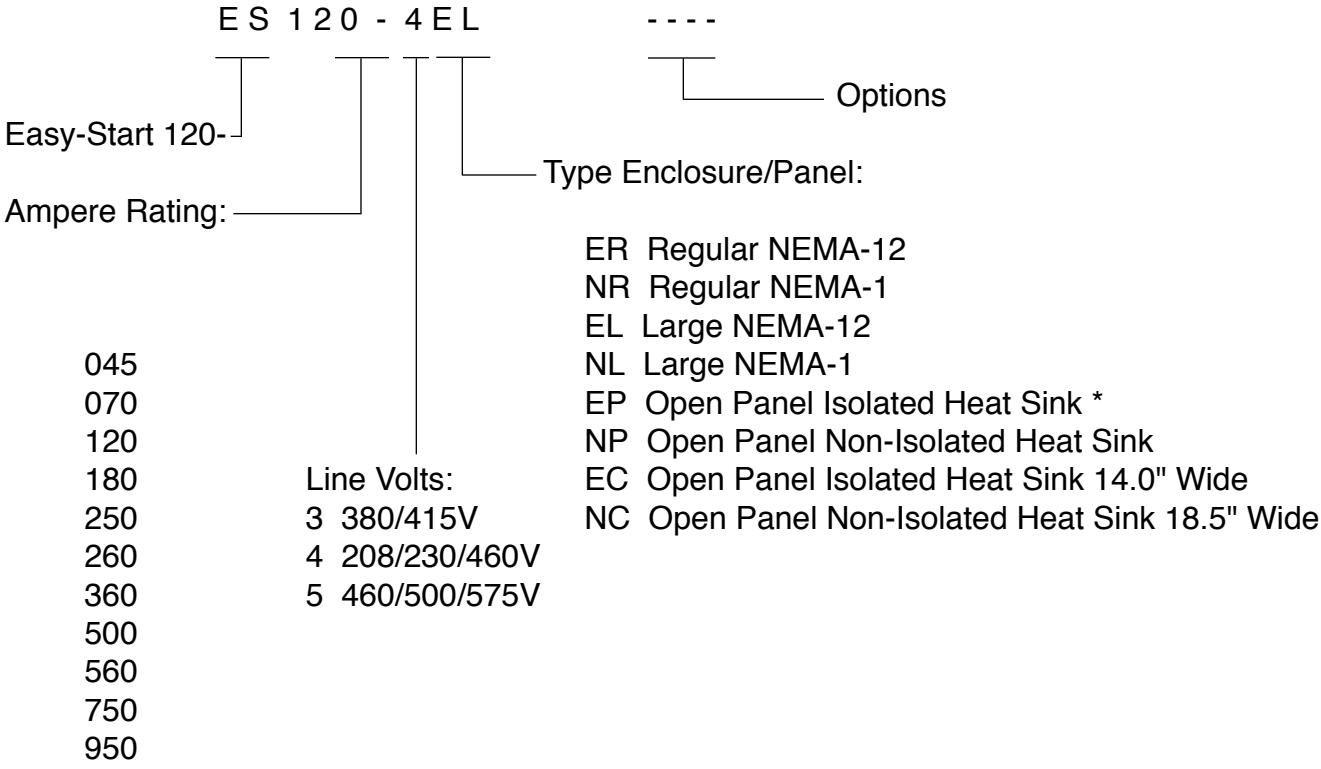
The amplifier also has a stability adjustment which can be used to handle difficult motor load applications. It is marked **STAB** and is factory set to approximately midpoint.

A ***digital trigger*** is used on the SCR gates. It gives near perfect balance of motor voltage between phases. Its hard firing and fast rise-time gate pulses insure positive firing of the SCR's. Its wide range insures motor voltage control from zero to full line voltage with power factors from 0.1 to 1.0.

The ***current unbalance*** circuit senses each line current and the signals are sent to comparators. The circuit senses when the line currents are unbalanced and trips the starter off line whenever the unbalance is greater than 20% from the average. This feature is useful in diagnostics and will be covered more in the troubleshooting section of this manual.

The ***lockout*** is an input to the digital trigger. It is at a logic "high" during normal operation. It is forced to a logic "low" by any one of the protective or alarm functions. In this low state the gates of the digital trigger are inhibited or "locked out" to prevent firing of the SCR's.

Model Designation



Notice -

* ES045_EP, ES070_EP, EC, and ES120_EP, EC are isolated heat sinks.
All other open panel models are non-isolated heat sinks.

Application Considerations

Installation

1. Ventilated NEMA 1 enclosures should be mounted so that enough clearance is available for air to enter and exit the enclosure. Specific clearance requirements are shown on enclosure dimension drawings.

2. NEMA 12 enclosures should be mounted so that heat sink fins are vertical. For wall mounted units a minimum clearance of 6" on top and bottom is required.

3. Open panel units should be mounted in a box so the temperature inside the box does not exceed 50°C (122°F).

   For sizing the enclosure the heat loss in watts can be estimated at 3 times the full load current.

   EXAMPLE: For ES180-4N the maximum current rating is 180 amps. The approximate watts loss at maximum current rating is 3 x 180 = 540 watts.

For units with non isolated heat sinks, all the watt loss must be dissipated thru box surface.

For units with isolated heat sinks; the heat sink fins should be brought out in open air thru a properly gasketed cut out in the enclosure. Approximately 50% watt loss is dissipated thru the heat sinks and the remaining 50% should be dissipated thru the remainder of the box surface, not counting the heat sink.

Ambient Temperature

Easy-Start ES is rated for 40°C (104°F) ambient temperature. For above 40°C derate by 5% for every 5°C rise over 40°C up to 50°C (122°F) max.

EXAMPLE: ES180-4N is rated 180 Amps @ 40°C. For 50°C the rating would be 180 x 0.9 = 162 Amps

Altitude

Easy-Start ES is rated for 3300 ft. [1000 meters]. Use Figure 2-5 for derating above 3300 ft.

Multi-Motor Operation

Easy-Start ES can be used to control multiple motors if the following conditions are met:

The current rating of Easy-Start ES should be equal to or greater than the total of individual motor full load amps and DIP switches must be set for the cumulative full load amps of the motors.

Individual motor overcurrent protection is provided by others.

Energy Saver circuit should be turned **OFF**.

The motors should not be mechanically coupled together, i.e. two motors on same shaft.

NEC and local code requirement for individual motor protection and branch circuit protection are met.

Application Considerations

Frequent Starting/Stopping

The number of starts and stops depends upon many factors. The most important ones are:

1. Position of current limit potentiometer which can be anywhere from 200-500% of the current rating set by the DIP switches.
2. Start time.
3. Run time.
4. Off time before next start.

The following tables (Table 2-1 thru Table 2-11) can be used for guidance in frequent starting/stopping application. These tables are based on worst case condition that the controller will be running at the indicated starting current during the entire start time.

The number of ***starts-per-hour*** in the following tables is based on the current carrying capacity of the Easy-Start ES. If a high number of multiple starts is used, the starter may trip due to the inverse-time overload current protection function.

If a trip should occur, due to multiple starts, it is advisable to wait a period of 10 minutes before re starting to avoid damage to the Easy-Start ES.

Notice - The motor manufacturer should be consulted about the effect of a high number of multiple starts on motor life.

Zero % off-time in the starts per hour tables, indicates jog duty.

EXAMPLE: If an application requires 1 start per minute, 60 starts per hour, for a 460V, 50 HP, 70 Amp motor; the cycle time is 60 seconds between starts. Assume a start time of 5 seconds, at a starting current of 500% (350 amps) is needed, with an off-time between run and start of 12 seconds, and a run time of 43 seconds.

The percent off-time is therefore 12/60 X 100 = 20%. We next look at the starts per hour Table 2-2 for a 70 amp starter (ES070). We can see that the model ES070 can do only 40 starts per hour at 350 amps with a start time of 5 seconds and an off-time of 20%.

Therefore, we need to use the next larger size starter, (ES120). From Table 2-3 we can see that 80 starts per hour are allowed at a starting current of 360 amps with a start time of 5 seconds and a 20% off-time, by using the model ES120.

Notice - The Easy-Start ES may trip due to overcurrent, if repeated starts at high current and long starting times, are used.

Starting Torque

The reduced voltage applied to the motor results in reduced inrush current and soft start. However, it reduces the starting torque of the motor. The relationship is as follows:

$$\frac{\textit{Torque at Reduced Current}}{\textit{Torque at Full Current}} = \left[\frac{\textit{Current at Reduced Voltage}}{\textit{Current at Full Voltage}}\right]^2$$

EXAMPLE: A 100 HP 1800 RPM 460V NEMA B motor draws six times full load amps for starting and starting torque is 150% of full load torque.

If the same motor is started with Easy-Start ES at 300% current limit.

$$\textit{Starting Torque at 300\% Current Limit} = \left[\frac{300}{600}\right]^2$$

x starting torque at 600% current = 1/4 x 150% full load torque = 37.5% full load torque

Application Considerations

NEMA Design C and D Motors, Wound Rotor Motors

These motors are used due to their high starting torque characteristics. When high starting currents and high starting torques are required, the extended time current option must be supplied and the unit must be oversized (see Section 4).

Reversing Starters

If all the limitations are understood and accepted the Easy-Start ES can be used on line side of an electro mechanical reversing starter. The operation should be to start the motor in forward or reverse after a complete stop. Plug reversing i.e. going from forward to reverse directly will damage the starter. It is recommended that enough time delay be built into the reversing starter circuit (by others) to prevent restarting until the motor has come to complete stop.

Wye Delta (Six Lead) Motors

These should be connected in Delta and can then be started with Easy-Start ES.

Part Winding Motors

Part winding motors are started by applying full voltage to part of the winding and after a time delay full voltage is applied to the remaining winding.

For part winding motors the Easy-Start ES can be used by connecting the two windings in parallel.

2-Speed 2-Winding Motor

If all the limitations are understood and accepted Easy-Start ES may be used on the line side of a electromechanical 2-speed 2-winding motor but will provide soft start only if the motor is started in either speed from complete stop. The ramp (soft start) can be optimized for one speed only.

Going directly from low speed to high speed or high speed to low speed would not give smooth transition and may cause a current surge. It is recommended that enough time delay be built into the 2-speed 2-winding starter circuit (by others) to prevent changing speeds without coming to full stop.

Another way is to connect Easy-Start ES between low speed contactor of electromechanical 2-speed starter and low speed winding of the motor. This will provide a soft start on low speed only.

2-Speed Single Winding Motors

The Easy-Start ES is not recommended for use with 2-speed single winding motors.

Capacitors

Notice - Power factor correction capacitors should not be connected between load side of Easy-Start ES and the motor. This will cause damage to the starter.

When the Easy-Start ES is operating at reduced voltage on the motor, there may be small amounts of harmonic current drawn from the AC power line. There may be a resonant circuit caused by capacitors across the line. The capacitors may therefore have a higher temperature rise than normal. This situation can be minimized by the following:

- If a contactor is used to switch the capacitors, it should have a time delay built in the circuit so that the contactor closes after the Easy-Start ES has ramped up to full voltage.
- The capacitors should be mounted as far upstream from the solid state starter as possible. If capacitors must be used they must be connected on the line side of the Easy-Start ES with at least 10 feet of cable between starter and the capacitors.

Application Considerations

Starting Time

The Easy-Start ES is designed to operate at 500% of its current calibration setting, (set by the DIP switches) for 20 seconds. If longer starting times are used, the Easy-Start ES will trip due to the overcurrent protection feature; (see Figure 3-1).

If longer starting times are required, the extended start-time option must be purchased. This option inhibits the inverse-time current trip during the extended start time.

Notice - Consult Motor Manufacturer for Effect of Longer Starting Time on Motor Life.

Suppose we have a 150 HP, 180 FLA motor which is driving a load with 120 second start time and the current limit is set for 500%, i.e. 900 amps. From Figure 4-1, Model ES180 will supply 900 amps but only for 40 seconds; therefore a larger unit such as ES260 is required. Using Figure 4-1, we see that ES260 will handle 900 amps for almost 200 seconds. So ES260 with extended start time option can be used for this application.

Circuit Breakers

The Easy-Start ES is capable of 500% current limit for 20 seconds. The circuit breakers, or protective devices used upstream, should be sized so that they can handle the maximum current for 20 seconds, or longer where extended start times are required.

Automatic Reset

Automatic reset normally is not used with the Easy-Start ES due to its 5 cycle ride-through capability. The control is wired for manual reset as standard.

Model Number ES045			Starts-Per-Hour			
Curr. Limit	Starting Current AC Amps	Start Time Sec.	Percent Off-Time			
			0%	10%	20%	30%
250%	113	2	180	240	360	480
		5	80	120	160	200
		10	50	70	85	100
		20	20	30	40	50
300%	135	2	150	220	300	360
		5	60	100	130	150
		10	40	50	60	70
		20	16	25	30	35
400%	180	2	100	160	200	240
		5	40	60	80	100
		10	20	30	40	50
		20	10	16	20	24
500%	225	2	80	120	150	180
		5	30	40	50	60
		10	12	16	20	24
		20	1	4	8	12

Starts-Per-Hour ES045
Table 2-1

Model Number ES070			Starts-Per-Hour			
Curr. Limit	Starting Current AC Amps	Start Time Sec.	Percent Off-Time			
			0%	10%	20%	30%
250%	175	2	180	240	320	480
		5	80	120	150	180
		10	40	60	70	80
		20	20	30	35	45
300%	210	2	120	200	240	320
		5	40	60	100	120
		10	20	30	40	60
		20	8	16	20	30
400%	280	2	60	120	160	200
		5	30	40	60	80
		10	12	20	30	40
		20	4	8	16	20
500%	350	2	40	80	120	140
		5	12	24	40	60
		10	4	8	16	20
		20	-	4	8	12

Starts-Per-Hour ES070
Table 2-2

Application Considerations

Model Number ES120			Starts-Per-Hour			
Curr. Limit	Starting Current AC Amps	Start Time Sec.	Percent Off-Time			
			0%	10%	20%	30%
250%	300	2	120	180	240	360
		5	70	90	120	150
		10	30	50	60	70
		20	15	20	25	30
300%	360	2	100	120	180	240
		5	40	60	80	100
		10	20	30	40	50
		20	10	16	20	24
400%	750	2	60	80	100	120
		5	30	40	50	60
		10	4	8	16	20
		20	-	2	4	6
500%	600	2	12	20	40	50
		5	8	12	20	24
		10	-	2	4	6
		20	-	-	-	1

Starts-Per-Hour ES120
Table 2-3

Model Number ES180			Starts-Per-Hour			
Curr. Limit	Starting Current AC Amps	Start Time Sec.	Percent Off-Time			
			0%	10%	20%	30%
250%	450	2	100	160	240	300
		5	40	60	80	100
		10	20	30	45	60
		20	10	15	20	30
300%	540	2	80	120	180	220
		5	30	40	60	80
		10	12	20	30	40
		20	8	10	12	16
400%	720	2	40	60	90	120
		5	20	30	40	50
		10	8	12	16	20
		20	4	8	10	12
500%	900	2	24	40	80	100
		5	12	20	30	40
		10	4	8	12	16
		20	-	2	4	6

Starts-Per-Hour ES180
Table 2-4

Application Considerations

Model Number ES250			Starts-Per-Hour			
Curr. Limit	Starting Current AC Amps	Start Time Sec.	Percent Off-Time			
			0%	10%	20%	30%
250%	625	2	120	180	240	300
		5	50	70	100	120
		10	25	40	50	60
		20	12	20	24	30
300%	750	2	80	120	160	220
		5	40	60	80	100
		10	20	30	40	50
		20	10	15	20	25
400%	1000	2	60	90	120	140
		5	24	35	50	60
		10	12	16	20	30
		20	4	8	12	15
500%	1250	2	30	50	70	100
		5	16	20	30	35
		10	8	10	15	20
		20	2	4	6	8

Starts-Per-Hour ES250
Table 2-5

Model Number ES260			Starts-Per-Hour			
Curr. Limit	Starting Current AC Amps	Start Time Sec.	Percent Off-Time			
			0%	10%	20%	30%
250%	650	2	120	180	240	300
		5	40	60	100	120
		10	20	30	50	60
		20	10	15	25	30
300%	540	2	60	120	160	220
		5	30	50	70	90
		10	12	20	30	40
		20	8	12	16	20
400%	720	2	40	60	100	120
		5	20	30	40	50
		10	8	12	16	24
		20	4	6	8	12
500%	900	2	20	40	60	80
		5	8	12	20	30
		10	4	8	12	16
		20	-	2	4	6

Starts-Per-Hour ES260
Table 2-6

Application Considerations

Model Number ES360			Starts-Per-Hour			
Curr. Limit	Starting Current AC Amps	Start Time Sec.	Percent Off-Time			
			0%	10%	20%	30%
250%	900	2	120	200	300	400
		5	60	100	120	160
		10	30	50	60	80
		20	16	25	30	40
300%	1080	2	100	150	200	250
		5	40	60	100	120
		10	20	30	45	60
		20	10	20	25	30
400%	1440	2	60	100	140	180
		5	30	40	50	60
		10	15	20	25	30
		20	8	10	12	16
500%	1800	2	40	60	80	100
		5	20	30	40	50
		10	10	15	20	25
		20	4	8	10	12

Starts-Per-Hour ES360
Table 2-7

Model Number ES500			Starts-Per-Hour			
Curr. Limit	Starting Current AC Amps	Start Time Sec.	Percent Off-Time			
			0%	10%	20%	30%
250%	1250	2	200	240	360	480
		5	80	120	160	200
		10	40	60	80	100
		20	20	30	40	50
300%	1500	2	120	200	240	300
		5	60	80	100	120
		10	30	40	50	60
		20	15	20	25	30
400%	2000	2	80	120	160	200
		5	40	60	80	100
		10	20	30	40	50
		20	10	15	20	25
500%	2500	2	60	80	100	120
		5	25	30	40	50
		10	10	15	20	25
		20	4	8	12	16

Starts-Per-Hour ES500
Table 2-8

Application Considerations

Model Number ES560			Starts-Per-Hour			
Curr. Limit	Starting Current AC Amps	Start Time Sec.	Percent Off-Time			
			0%	10%	20%	30%
250%	1400	2	100	180	300	400
		5	50	80	100	120
		10	24	40	60	80
		20	12	20	30	40
300%	1680	2	80	140	200	240
		5	40	60	80	100
		10	16	20	30	40
		20	8	16	20	24
400%	2240	2	50	100	120	140
		5	20	30	40	60
		10	8	16	20	24
		20	4	8	12	16
500%	2800	2	30	40	60	100
		5	12	20	30	40
		10	4	8	12	16
		20	-	2	4	6

Starts-Per-Hour ES560
Table 2-9

Model Number ES750			Starts-Per-Hour			
Curr. Limit	Starting Current AC Amps	Start Time Sec.	Percent Off-Time			
			0%	10%	20%	30%
250%	1875	2	180	240	320	400
		5	80	100	120	150
		10	40	50	70	80
		20	20	25	30	40
300%	2250	2	120	200	240	300
		5	60	80	100	120
		10	30	40	50	60
		20	10	20	25	30
400%	3000	2	80	120	150	180
		5	30	40	50	60
		10	15	25	30	35
		20	8	10	12	16
500%	3750	2	60	80	100	120
		5	25	30	40	50
		10	10	15	20	25
		20	4	8	10	12

Starts-Per-Hour ES750
Table 2-10

Application Considerations

Model Number ES950			Starts-Per-Hour			
Curr. Limit	Starting Current AC Amps	Start Time Sec.	Percent Off-Time			
			0%	10%	20%	30%
250%	2375	2	150	200	300	360
		5	60	90	120	150
		10	30	45	60	70
		20	15	20	30	35
300%	2850	2	100	150	200	250
		5	40	60	80	100
		10	20	30	40	50
		20	10	15	20	25
400%	3800	2	60	100	120	150
		5	25	40	50	60
		10	10	20	25	30
		20	4	8	12	15
500%	4750	2	30	50	80	100
		5	15	20	30	40
		10	6	8	10	12
		20	1	2	4	8

Starts-Per-Hour ES950
Table 2-11

Considerations For Field Wiring

The Easy-Start ES requires the following basic electrical connections: (Refer to Section 2 for connection diagrams.)

1. Three-phase line power. (Install proper voltage plug, see Section 3.)
2. Three-phase AC motor connection.
3. Ground connections.
4. 120 VAC control power, and **RESET** Pushbutton.
5. Check CPT connections on fan cooled models.

The three-phase line power can be from a suitable disconnect switch or a circuit breaker. By checking your particular options on your starter, or by visual inspection, you can determine if your starter has a factory installed circuit breaker.

The motor must be a three-wire AC induction motor.

The 120 VAC can be supplied from a separate source, or from a control transformer such as a 480V/120V connected to the three-phase line. By checking your particular options on your starter, or by visual inspection, you can determine if your starter has a factory installed isolation transformer. See option section for CPT connections.

After a trip, the Easy-Start ES must be reset by momentarily opening the 120 VAC on the logic board transformer T2. This is done by using a normally closed **RESET** pushbutton between TB1 3 and TB1-17 on the logic board. Should incoming power to the Easy-Start ES be lost for a period of time (over 10 seconds) the Easy-Start ES will automatically reset itself and be prepared for a normal start upon restoration of power. (This point is important should a customer choose to start the Easy-Start ES by an external contact closure rather than by standard three-wire pushbutton controls.)

Fan Control Power Transformer

Easy-Start ES models rated 250 amps and above are supplied with fans. The fans operate at 110/120 VAC supplied by a factory installed multi-voltage control power transformer. Two primary fuses FU-1 and FU-2 are supplied.

Notice - K102 relay is used to control the fans. The relay is turned on and off by the start/stop 120 VAC control voltage.

A thermostat (close on temperature rise) is connected across relay K102 contact and keeps the fans running after the motor is turned off, if the temperature in the enclosure is above the thermostat specified limit. (Refer to Figures 2-9 and 2-10.)

Considerations For Field Wiring

Hevi-Duty Company - Multi Volt Transformer Connections

The fan CPT is factory connected as follows:

Easy-Start ES Voltage Rating	Voltage Rating Used For Transformer Connections
208/230/460	460V
380/415	380V
460/500/575	575V

If the incoming line voltage is different than the factory connected rated voltage shown in previous paragraph, reconnect the multi-voltage transformer primary and secondary as follows for Hevi-Duty Company:

Line Voltage	Primary FU-2 Connection	Secondary Connection	Secondary Voltage
208 VAC	H2	X4	110 VAC
230 VAC	H2	X3	115 VAC
380 VAC	H3	X4	120 VAC
415 VAC	H3	X3	120 VAC
460 VAC	H4	X3	115 VAC
500 VAC	H5	X4	110 VAC
575 VAC	H5	X3	115 VAC

The primary to FU-1 is factory connected to H1. One secondary lead is factory connected to X1. The X1 and H1 connections remain the same for all line voltages.

Wiring Practices

Care should be taken to see that all interconnecting wiring and ground wiring is sized and installed in conformance with the National Electric Code (NEC) published by the National Fire Protection Association or the Canadian Electrical Code (CEC) as applicable and other appropriate local codes. Refer to controller and motor nameplates for electrical data.

Phase Rotation

The Easy-Start ES has built-in phase rotation protection. If the 3-phase incoming lines that are connected to the Easy-Start ES line terminals (marked A, B, C) are not A-B-C rotation, the fault light “phase rot” will light up on the logic board, and front door if mounted in a standard enclosure. This feature also inhibits starting of the motor. In order to correct the rotation, reverse any two lines going into the Easy-Start ES line terminals. Once the phase rotation is determined, and if the motor is running in the wrong direction, reverse any two motor leads on the load side of the Easy-Start ES.

Considerations For Field Wiring

Cutler-Hammer Transformer Connections

The fan CPT is factory connected as follows:

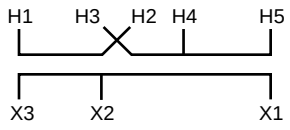
Easy-Start ES Voltage Rating	Voltage Rating Used For Transformer Connections
208/230/460	460V
380/415	380V

If the incoming line voltage is different than the factory connected rated voltage shown in previous paragraph, reconnect the multi-voltage transformer primary and secondary as follows for Cutler-Hammer transformers:

Line Voltage	Primary FU-2 Connection	Secondary Connection	Jumper	Secondary Voltage
208 VAC	H5	X3	H1 to H3 & H2 to H5	110 VAC
380 VAC	H4	X3	H2 to H3	120 VAC
415 VAC	H5	X3	H2 to H3	120 VAC
460 VAC	H4	X2	H2 to H3	115 VAC
230 VAC	H4	X2	H1 to H3 & H2 to H4	115 VAC

The primary to FU1 is factory connected to H1.
One secondary lead is factory connected to X1.
The X1 and H1 connections remain the same for all line voltages.

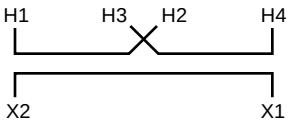
Diagram 2



Volts		Connect	Lines
	B		
	416	H2 to H3	H1-H5
	380	H2 to H3	H1-H4
		H1 to H3 & H2 to H4	H1-H4
	208	H1 to H3 & H2 to H5	H1-H5
	115		X1-X3
	95		X1-X2

Easy ES-050

Diagram 1



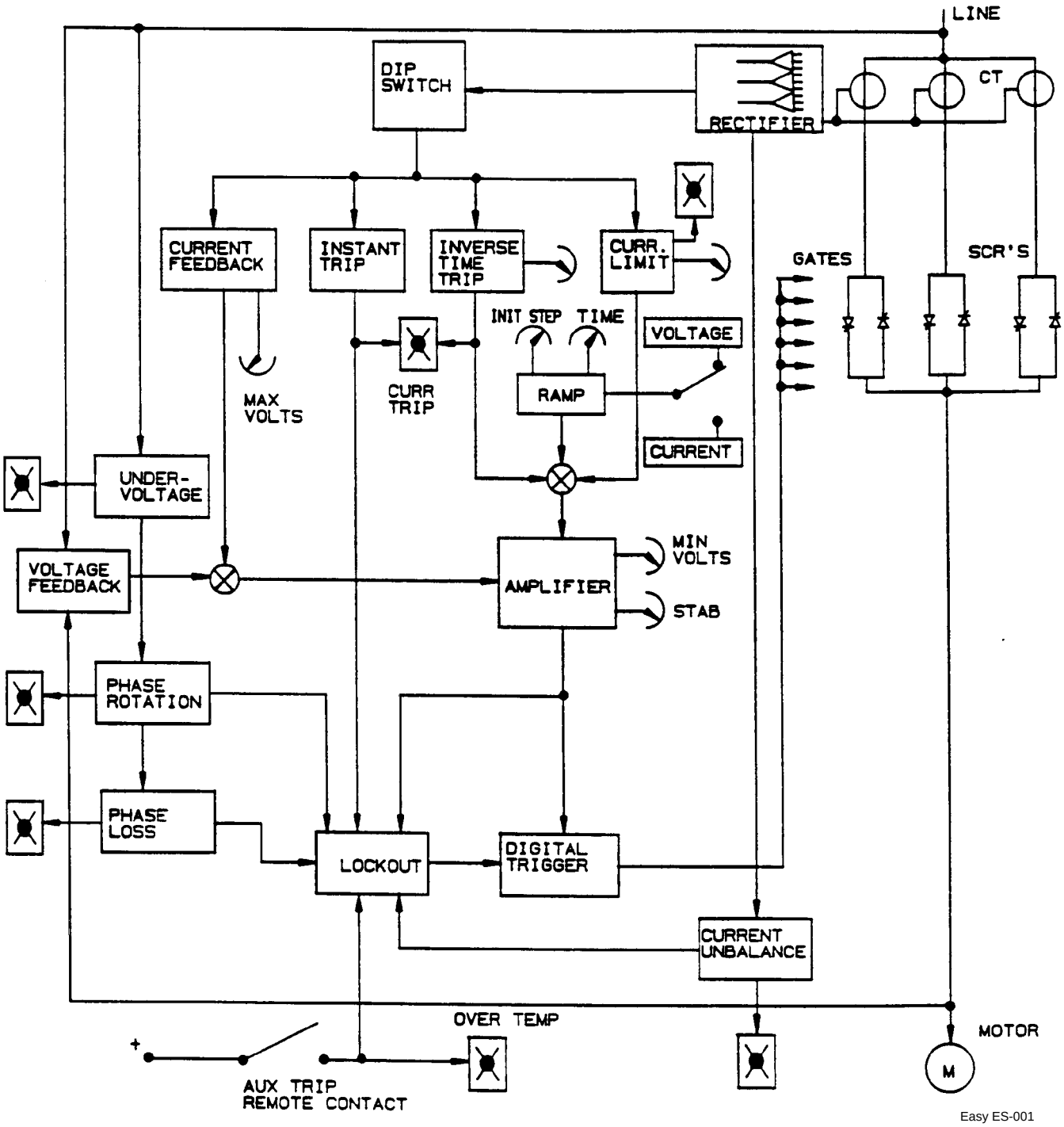
Volts	Connect	Lines
460	H2 to H3	H1-H4
230	H1 to H3 & H2 to H4	H1-H4
115		X1-X2

Easy ES-051

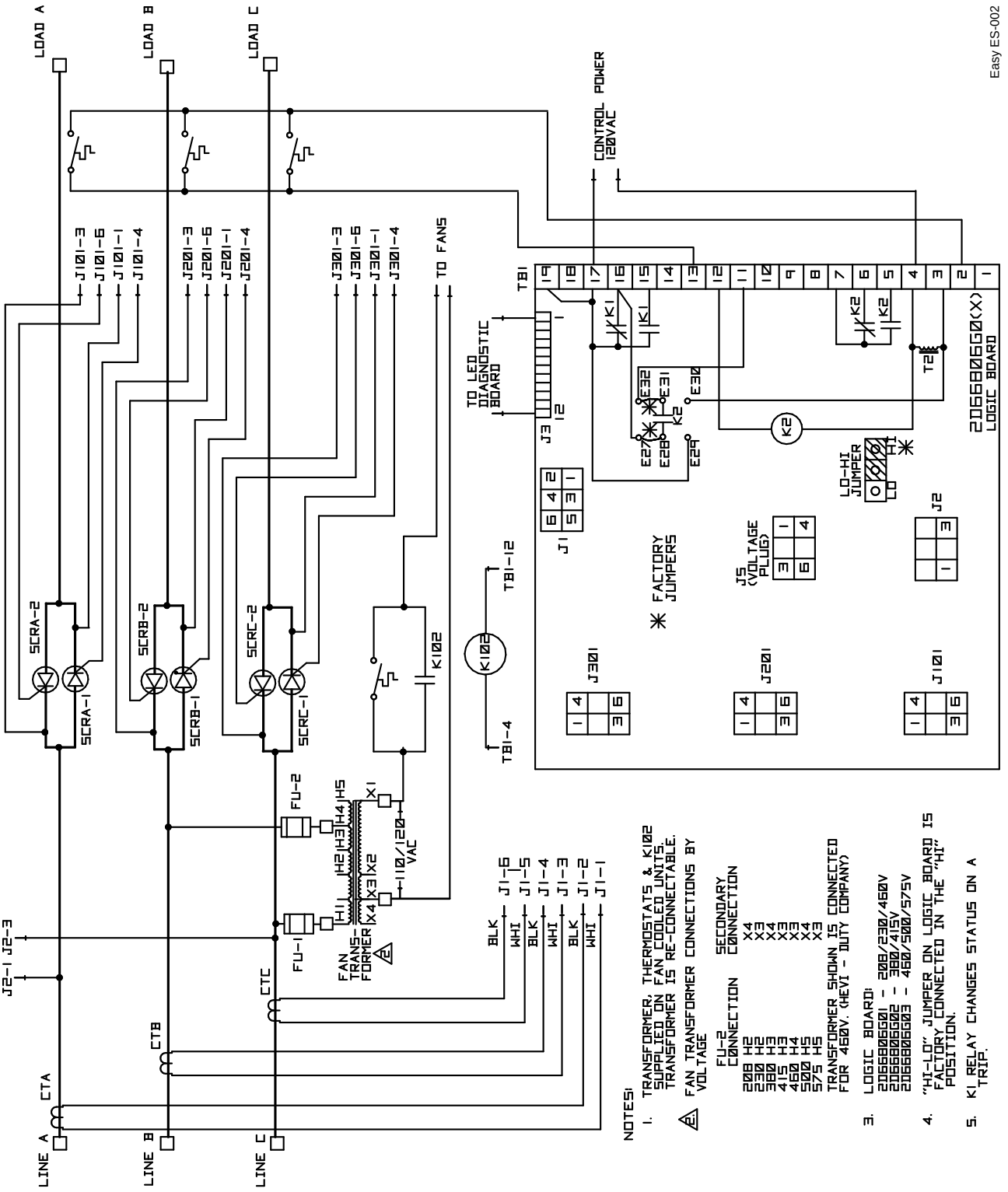
Drawings

This part of the *Installation* section of this Instruction Manual presents the following series of drawings:

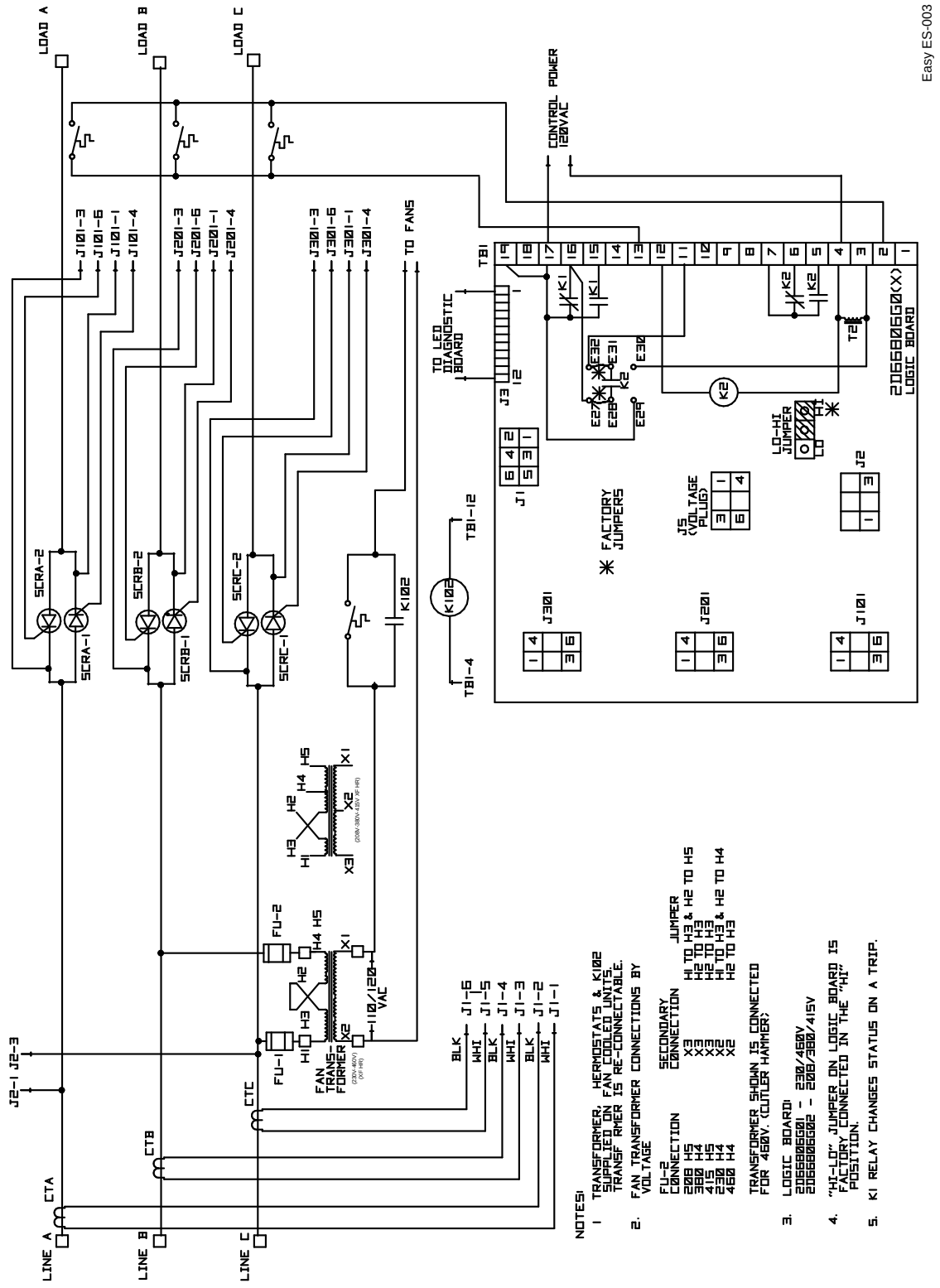
- Overload Characteristics.
- Control Connection and Schematic Diagrams.
- Outline dimensions and options for mounting each chassis.



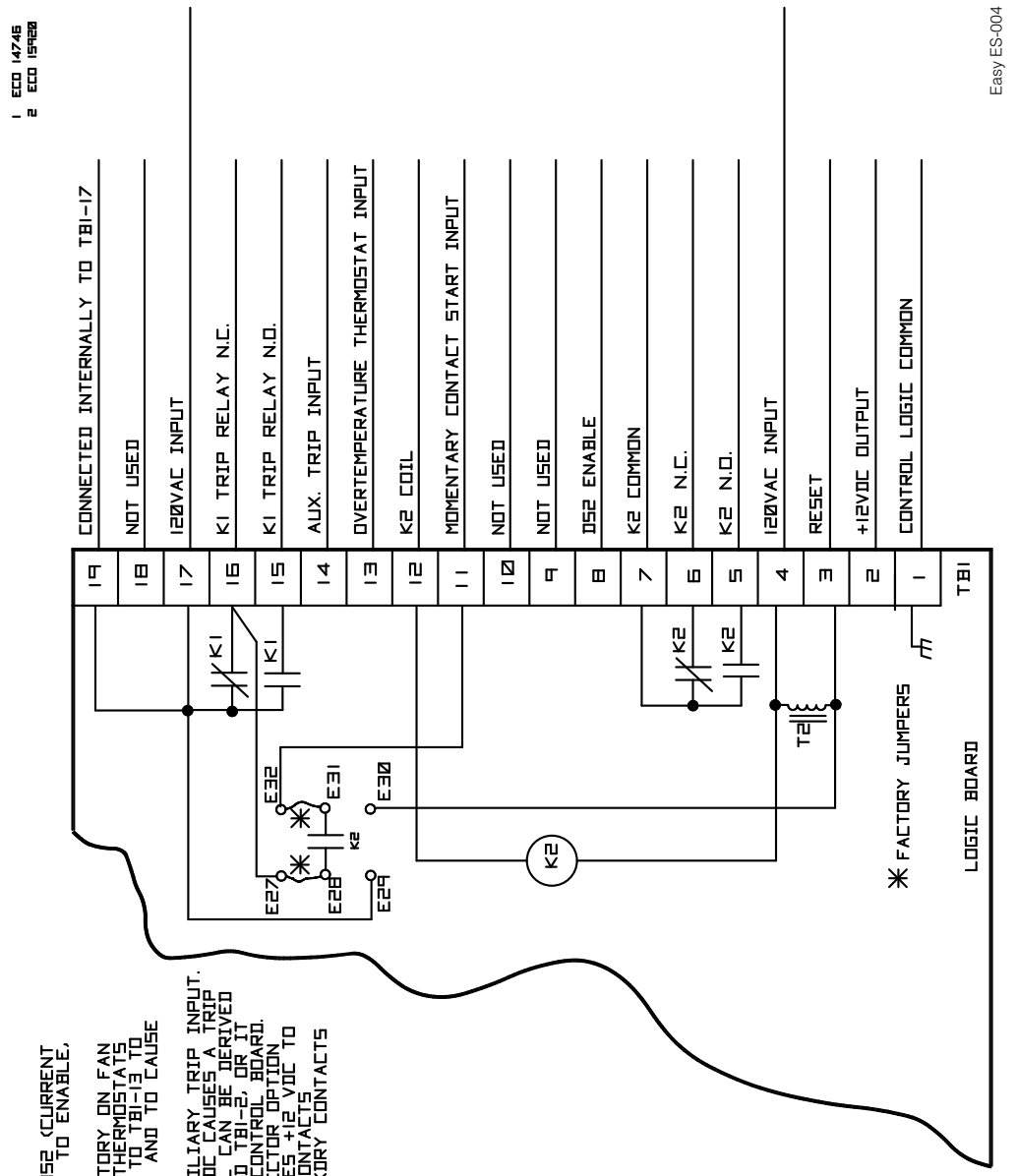
Block Diagram
Figure 2-1



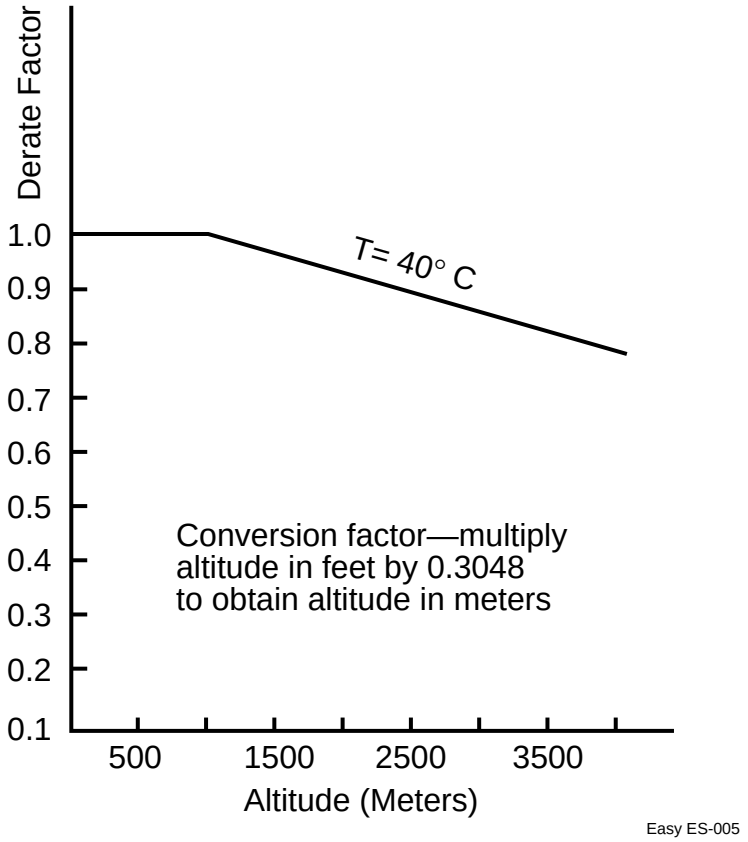
System Schematic (Hevi-Duty Co. Multi Volt Transformer Connections)
Figure 2-2



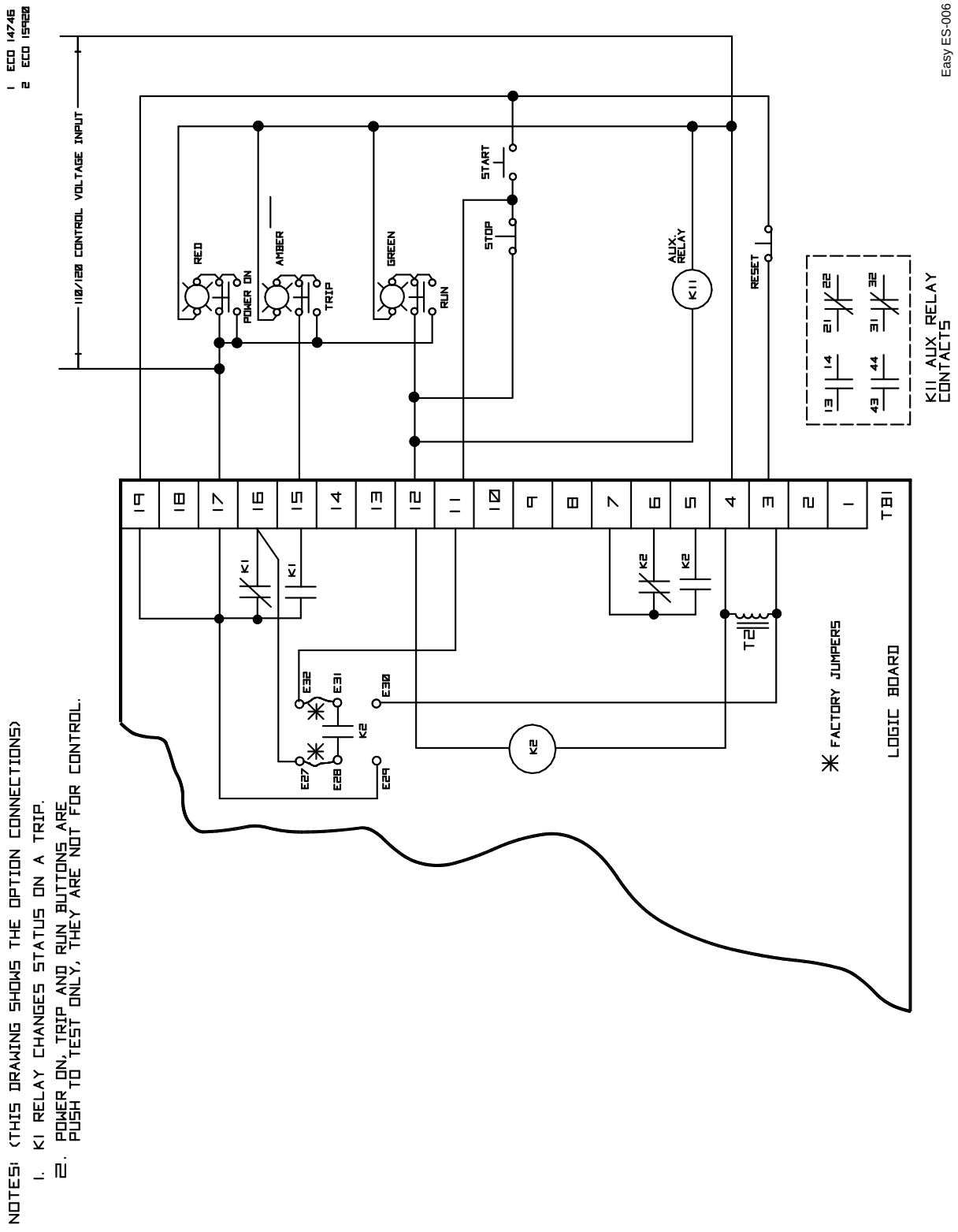
System Schematic (Cutler-Hammer Transformer Connections)
Figure 2-3


1 ECO 14746
2 ECO 15920
Easy ES-004
CONNECTED INTERNALLY TO TB1-17
NOT USED
120VAC INPUT
K1 TRIP RELAY N.C.
K1 TRIP RELAY N.O.
AUX. TRIP INPUT
OVERTEMPERATURE THERMOSTAT INPUT
K2 COIL
MOMENTARY CONTACT START INPUT
NOT USED
NOT USED
DS2 ENABLE
K2 COMMON
K2 N.C.
K2 N.O.
120VAC INPUT
RESET
+12VDC OUTPUT
CONTROL LOGIC COMMON
19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1
TB1
K1
K2
T2
E32
E31
E30
E27
E28
E29
FACTORY JUMPERS
LOGIC BOARD
NOTES:
1. TB1-8 IS USED TO ENABLE DS2 (CURRENT CALIBRATION DIP SWITCH). TO ENABLE, CONNECT TB1-2 TO TB1-8.
2. TB1-13 IS USED BY THE FACTORY ON FAN COOLED MODELS. THE N.O. THERMOSTATS ARE CONNECTED FROM TB1-2 TO TB1-13 TO INDICATE OVERTEMPERATURE, AND TO CAUSE A TRIP TO OCCUR.
3. TB1-14 IS USED AS AN AUXILIARY TRIP INPUT. CONNECTING TB1-14 TO +12VDC CAUSES A TRIP TO OCCUR. THIS 12V SIGNAL CAN BE DERIVED FROM THE MAIN LOGIC BOARD TB1-2, OR IT CAN COME FROM AN OPTION CONTROL BOARD. EXAMPLE: SHORTED SCR DETECTOR OPTION (FACTORY SUPPLIED) SUPPLIES +12 VDC TO TB1-14 OR USER SUPPLIED CONTACTS BETWEEN TB1-2 AND TB1-14 (DRY CONTACTS RECOMMENDED).

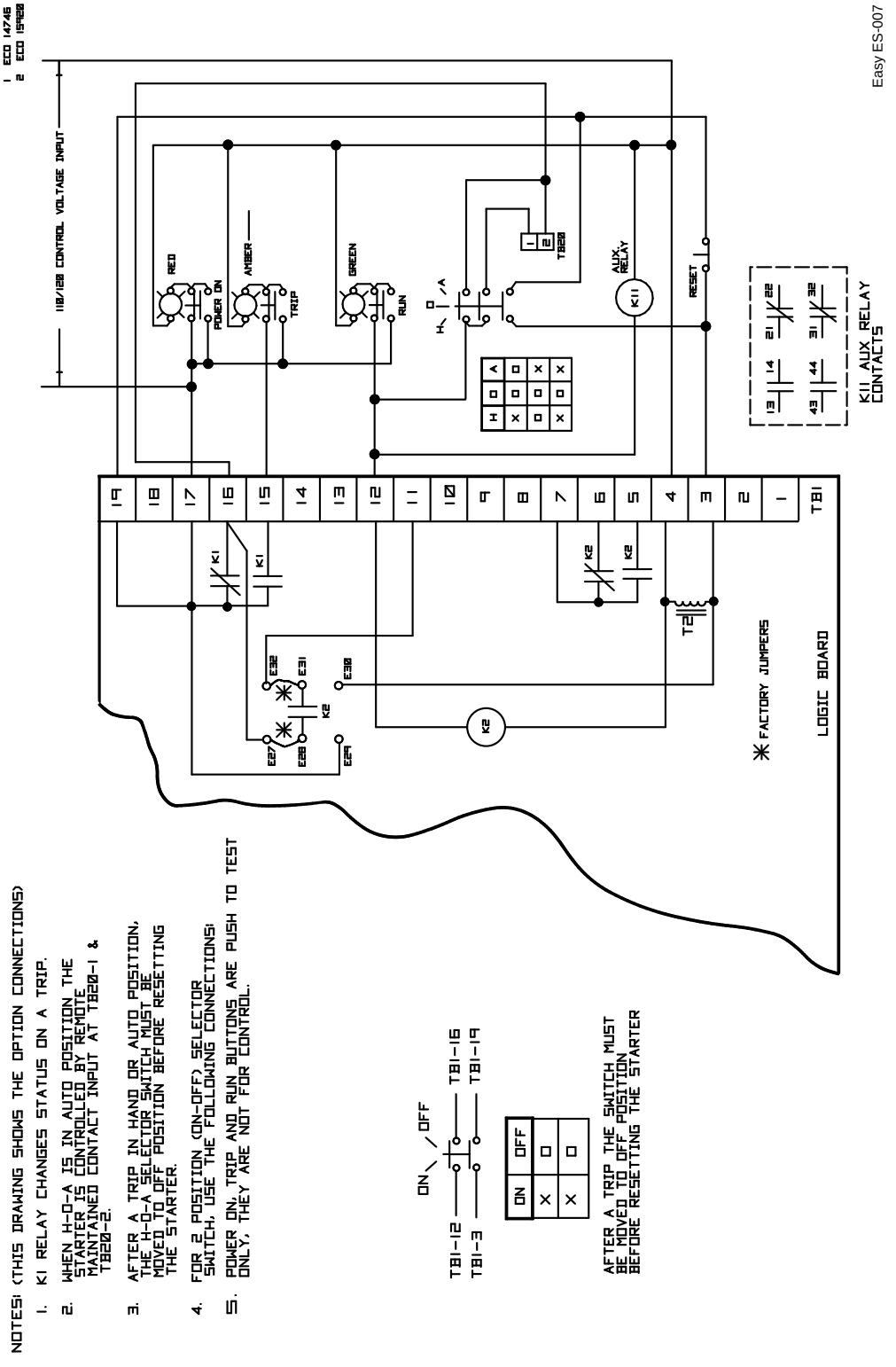
Logic Board Terminal Block TB1 Functions
Figure 2-4



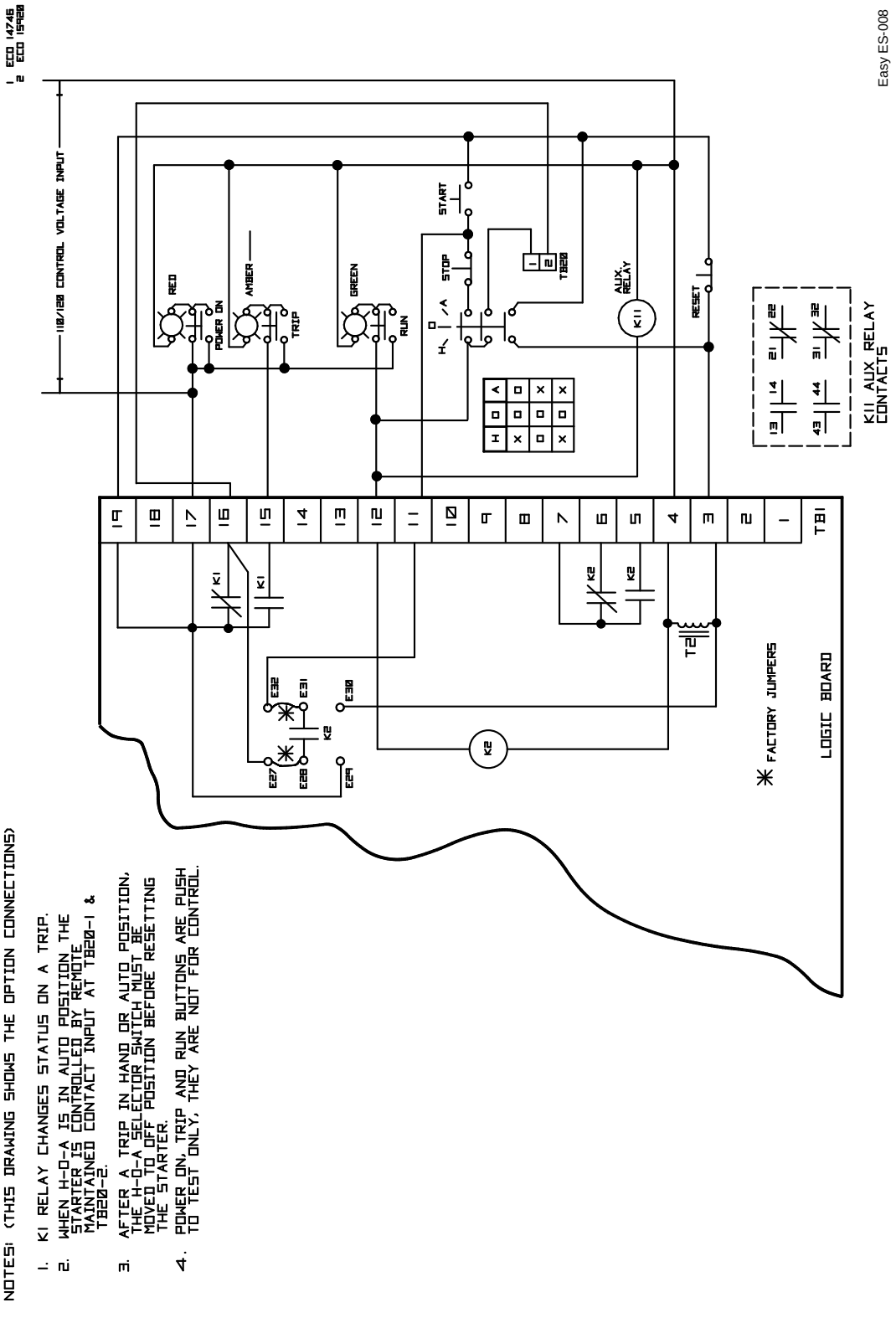
Derate Curve for Altitude
Figure 2-5



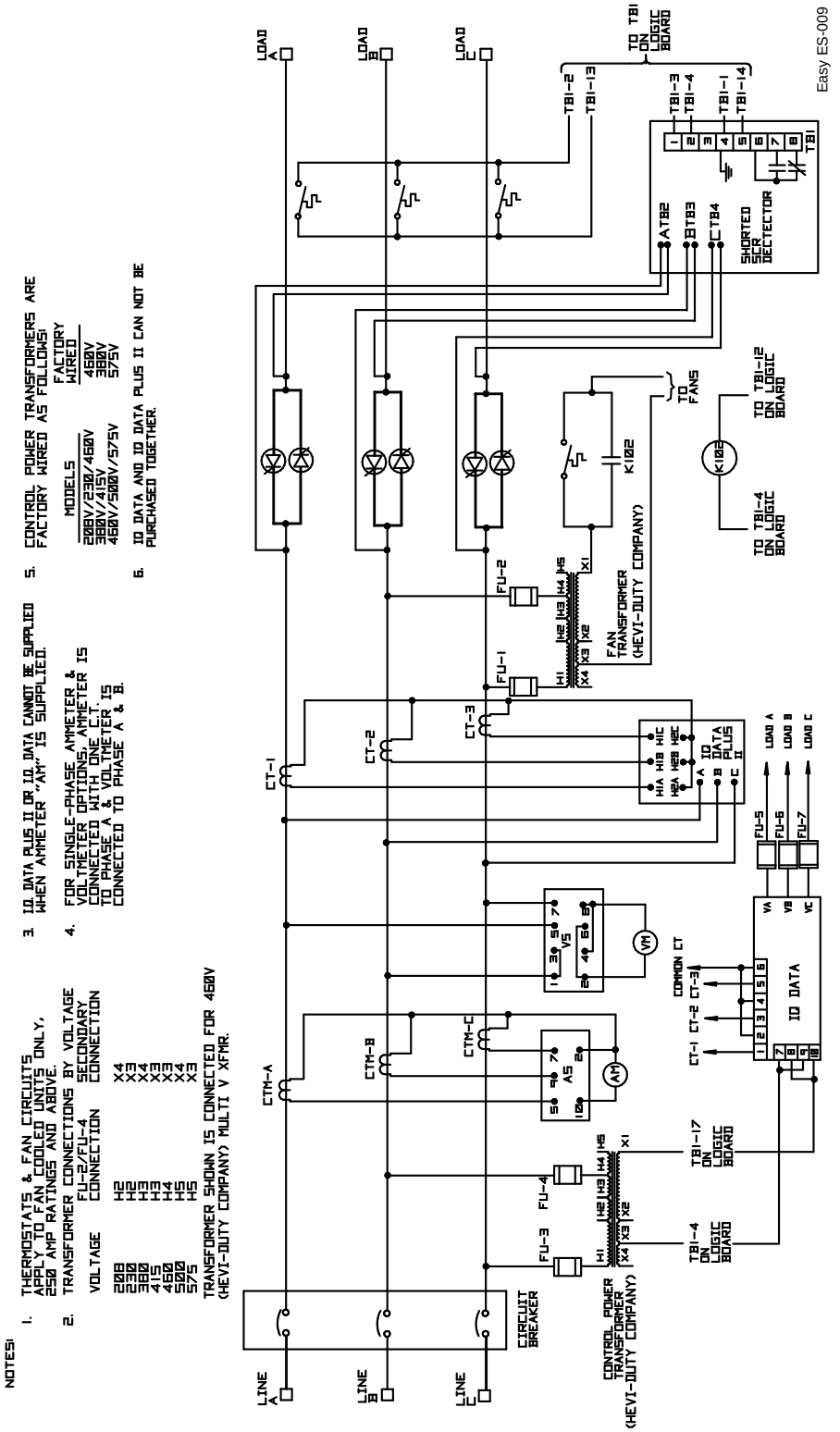
Momentary Contact Start/Stop Pushbuttons
Figure 2-6


1 ECO 14746
2 ECO 15920
Easy ES-007
110/120 CONTROL VOLTAGE INPUT
RED
POWER ON
AMBER
TRIP
GREEN
RUN
H O A
TB20
AUX. RELAY
K11
RESET
K11 AUX RELAY CONTACTS
13 14 21 22
43 44 31 32
19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 TB1
K1
K2
T2
E32 E31 E30
E27 E28 E29
FACTORY JUMPERS
LOGIC BOARD
ON / OFF
TB1-12
TB1-3
TB1-16
TB1-19
ON OFF
X
X
AFTER A TRIP THE SWITCH MUST BE MOVED TO OFF POSITION BEFORE RESETTING THE STARTER
NOTES: (THIS DRAWING SHOWS THE OPTION CONNECTIONS)
1. K1 RELAY CHANGES STATUS ON A TRIP.
2. WHEN H-O-A IS IN AUTO POSITION THE STARTER IS CONTROLLED BY REMOTE MAINTAINED CONTACT INPUT AT TB20-1 & TB20-2.
3. AFTER A TRIP IN HAND OR AUTO POSITION, THE H-O-A SELECTOR SWITCH MUST BE MOVED TO OFF POSITION BEFORE RESETTING THE STARTER.
4. FOR 2 POSITION (ON-OFF) SELECTOR SWITCH, USE THE FOLLOWING CONNECTIONS:
5. POWER ON, TRIP AND RUN BUTTONS ARE PUSH TO TEST ONLY, THEY ARE NOT FOR CONTROL.

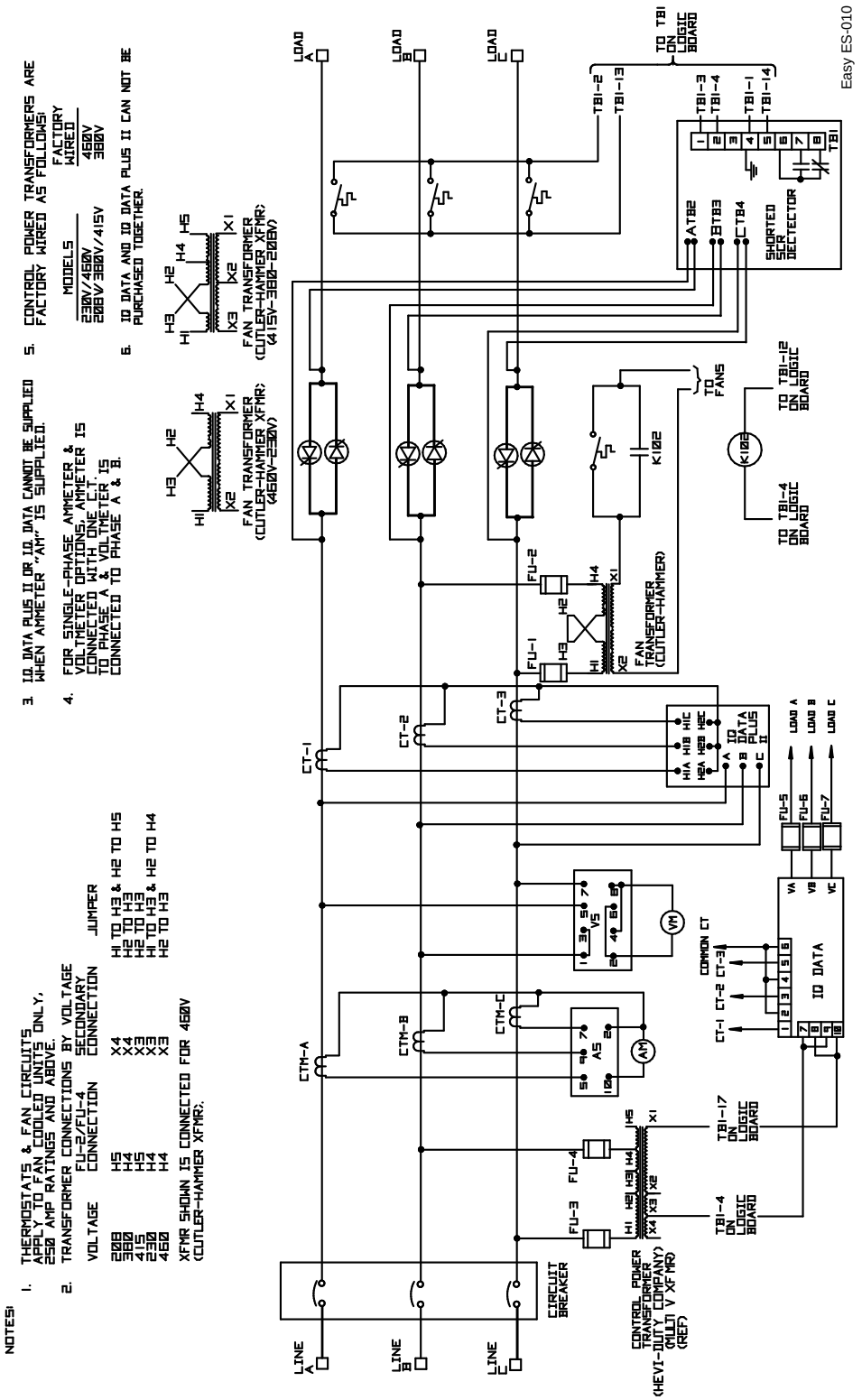
Hand-Off-Auto Selector Switch
Figure 2-7



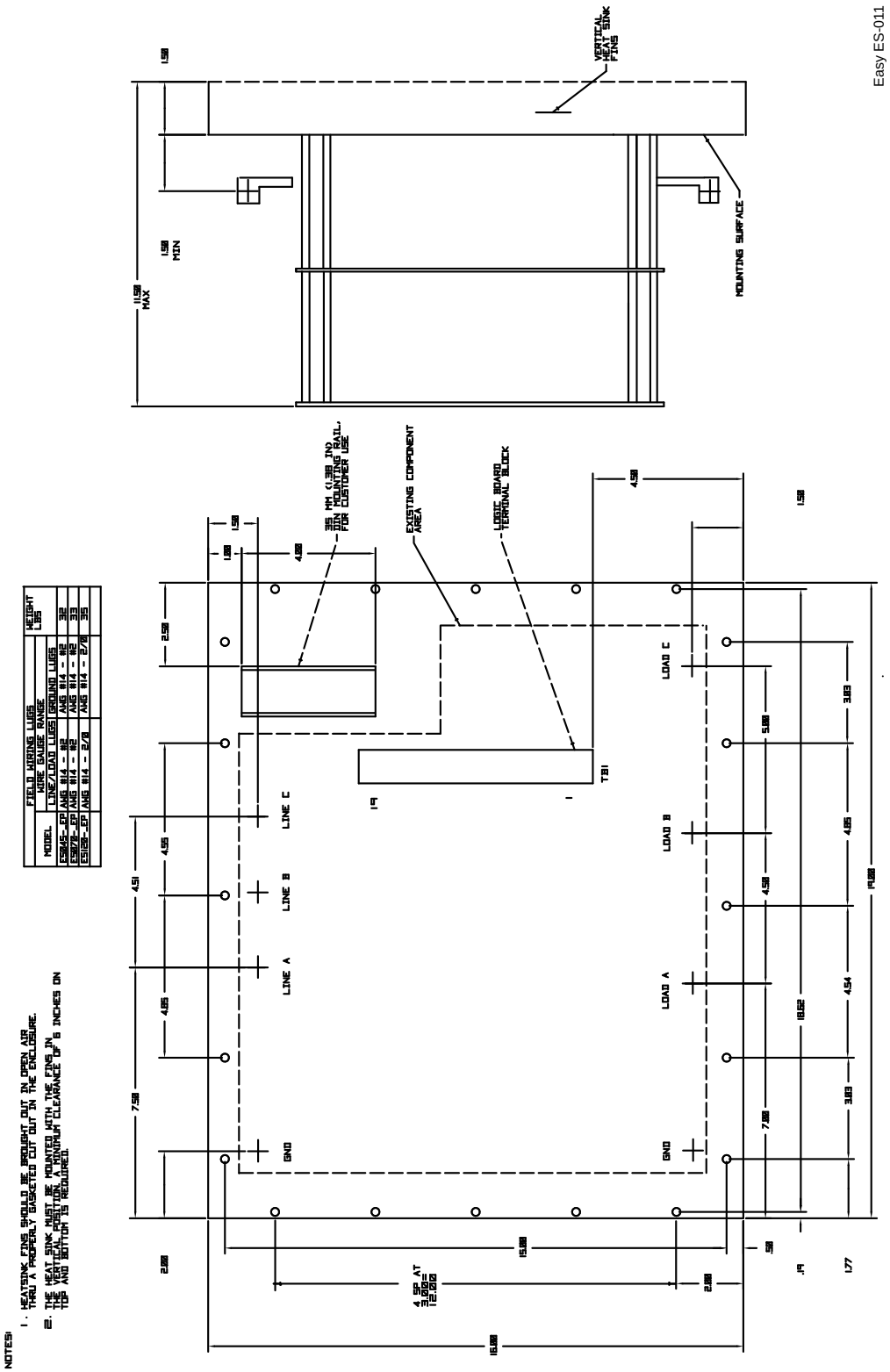
Start-Stop Pushbuttons With Hand-Off-Auto Selector Switch
Figure 2-8



Power Connections with Options (Hevi-Duty Co. Multi Volt Transformer)
Figure 2-9



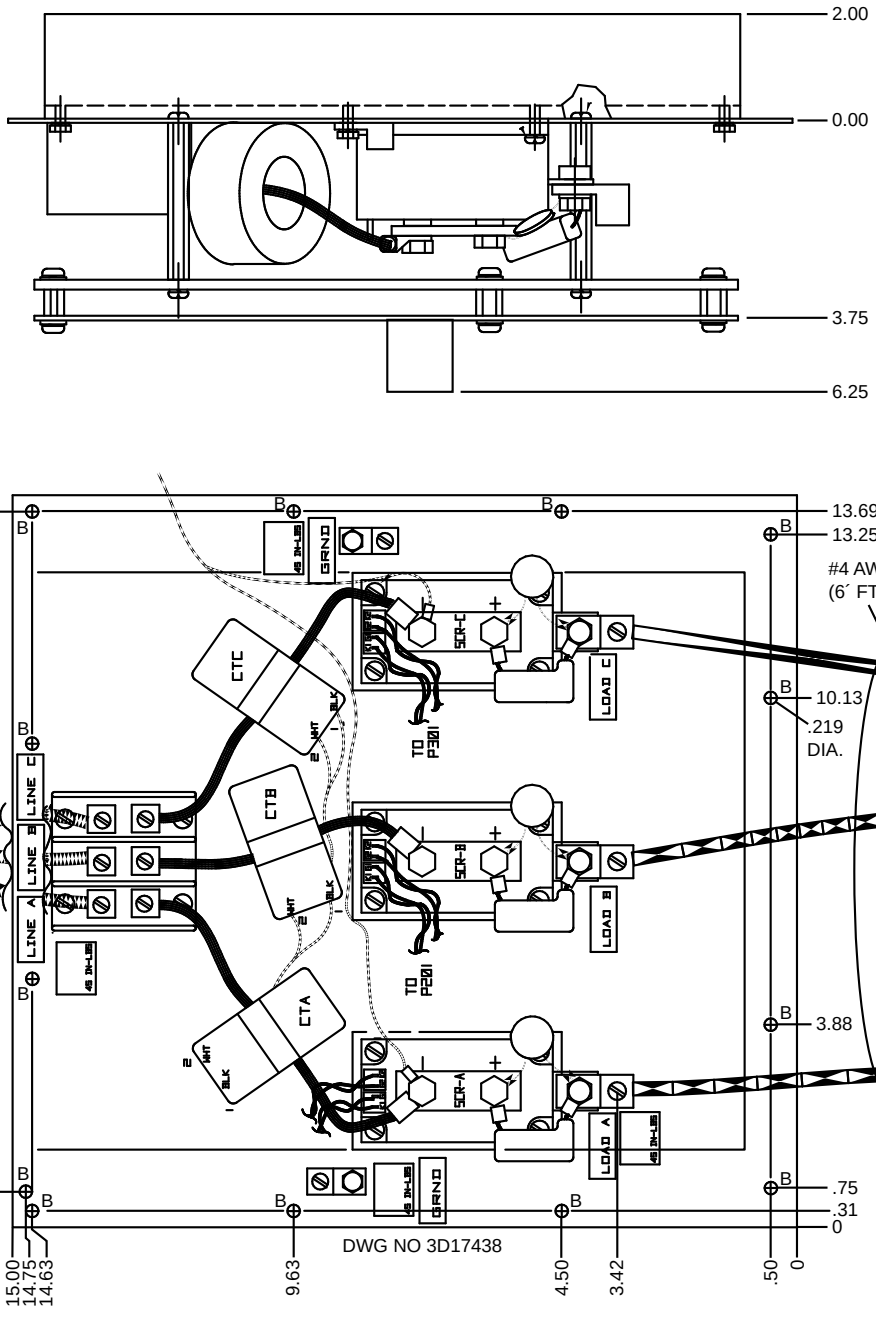
Power Connections with Options (Cutler-Hammer Transformer)
Figure 2-10


Easy ES-011
VERTICAL HEAT SINK FINS
MOUNTING SURFACE
1.50 MIN
11.50 MAX
35 MM (1.38) IN MOUNTING RAIL, FOR CUSTOMER USE
EXISTING COMPONENT AREA
LOGIC BOARD TERMINAL BLOCK
FIELD WIRING LUGS
MORE GAUGE RANGE
MODEL
LINE/LOAD LUGS
GROUND LUGS
WEIGHT LBS
ES045-_EP AWG #14 - #2 AWG #14 - #2 32
ES070-_EP AWG #14 - #2 AWG #14 - #2 33
ES120-_EP AWG #14 - 2/0 AWG #14 - 2/0 35
LINE C
LINE B
LINE A
LOAD C
LOAD B
LOAD A
GND
T2
T1
NOTES:
1. HEATSINK FINS SHOULD BE BROUGHT OUT IN OPEN AIR THRU A PROPERLY GASKETED CUT OUT IN THE ENCLOSURE.
2. THE HEAT SINK MUST BE MOUNTED WITH THE FINS IN VERTICAL POSITION. A MINIMUM CLEARANCE OF 6 INCHES ON TOP AND BOTTOM IS REQUIRED.

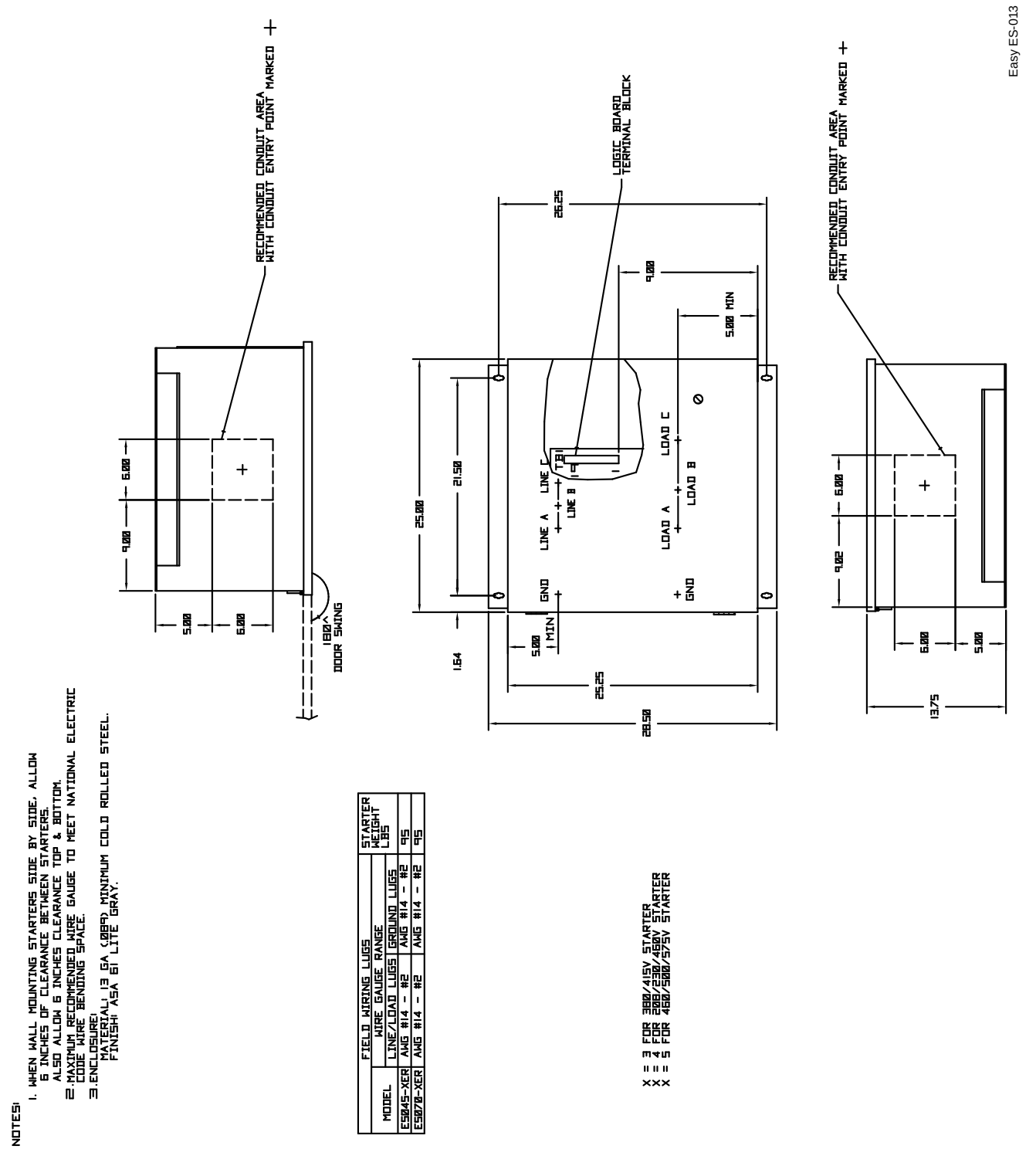
Dimension and Installation Open Panel ES045-_EP, ES070-_EP, ES120-_EP
Figure 2-11

NOTES
1. PANEL MATERIAL: 14 GA (.074) STEEL
   FINISH: ASA 61 LIGHT GRAY
2. PANEL SHOULD BE MOUNTED IN A VERTICAL POSITION TO PROVIDE PROPER COOLING.
3. WHEN DAUGHTER BD. OPTION IS USED DEPTH IS 7.50".

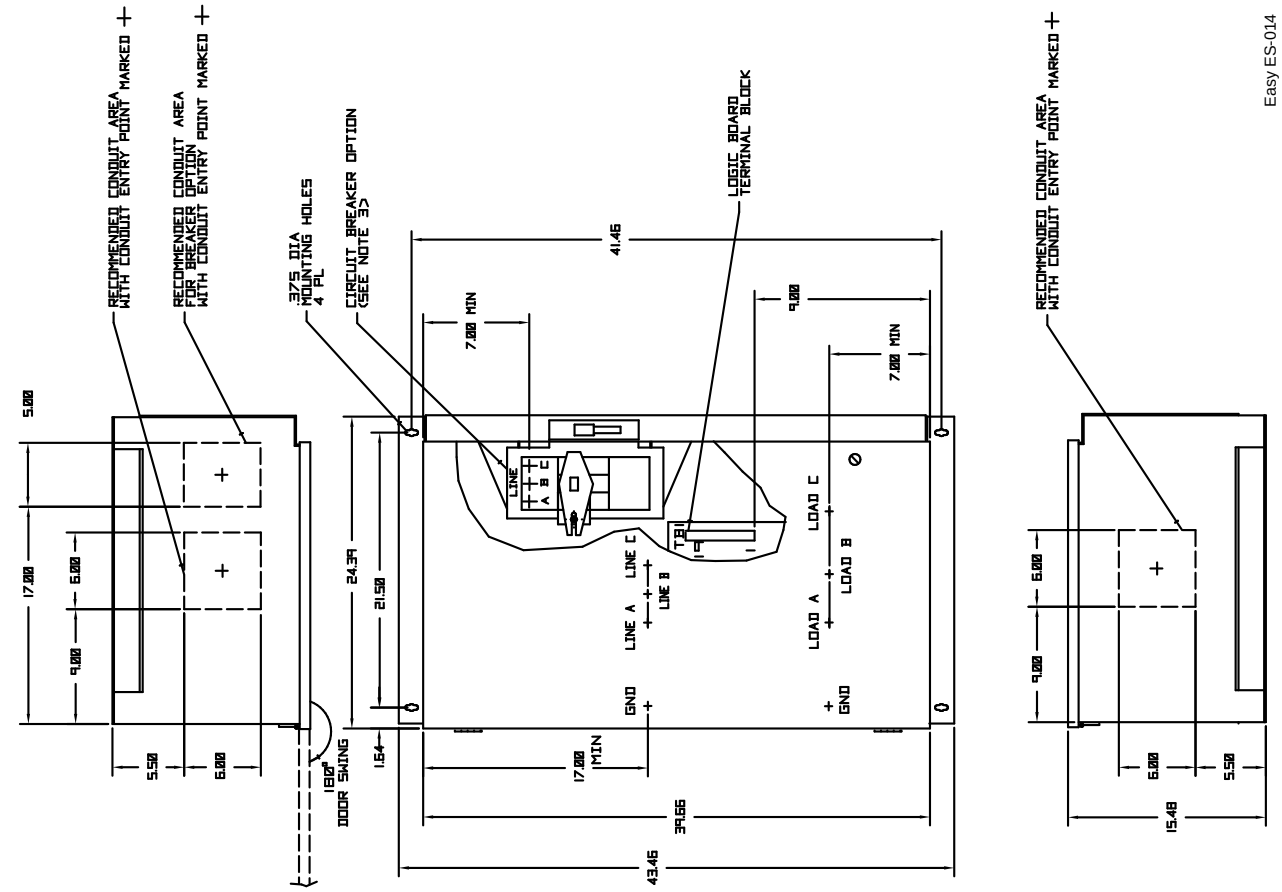
MODEL	FIELD WIRING LUGS		WEIGHT LBS
	WIRE GAUGE RANGE		
	LINE/LOAD LUGS	GROUND LUGS	
ES070-_EC	AWG 14-1\0	AWG 14-2	50



Dimension and Installation Open Panel Slim Line Motor Control Center ES070-_EC
Figure 2-12



Dimension and Installation NEMA-12 Regular Enclosure ES045-_ER, ES070-_ER
Figure 2-13



NOTES:

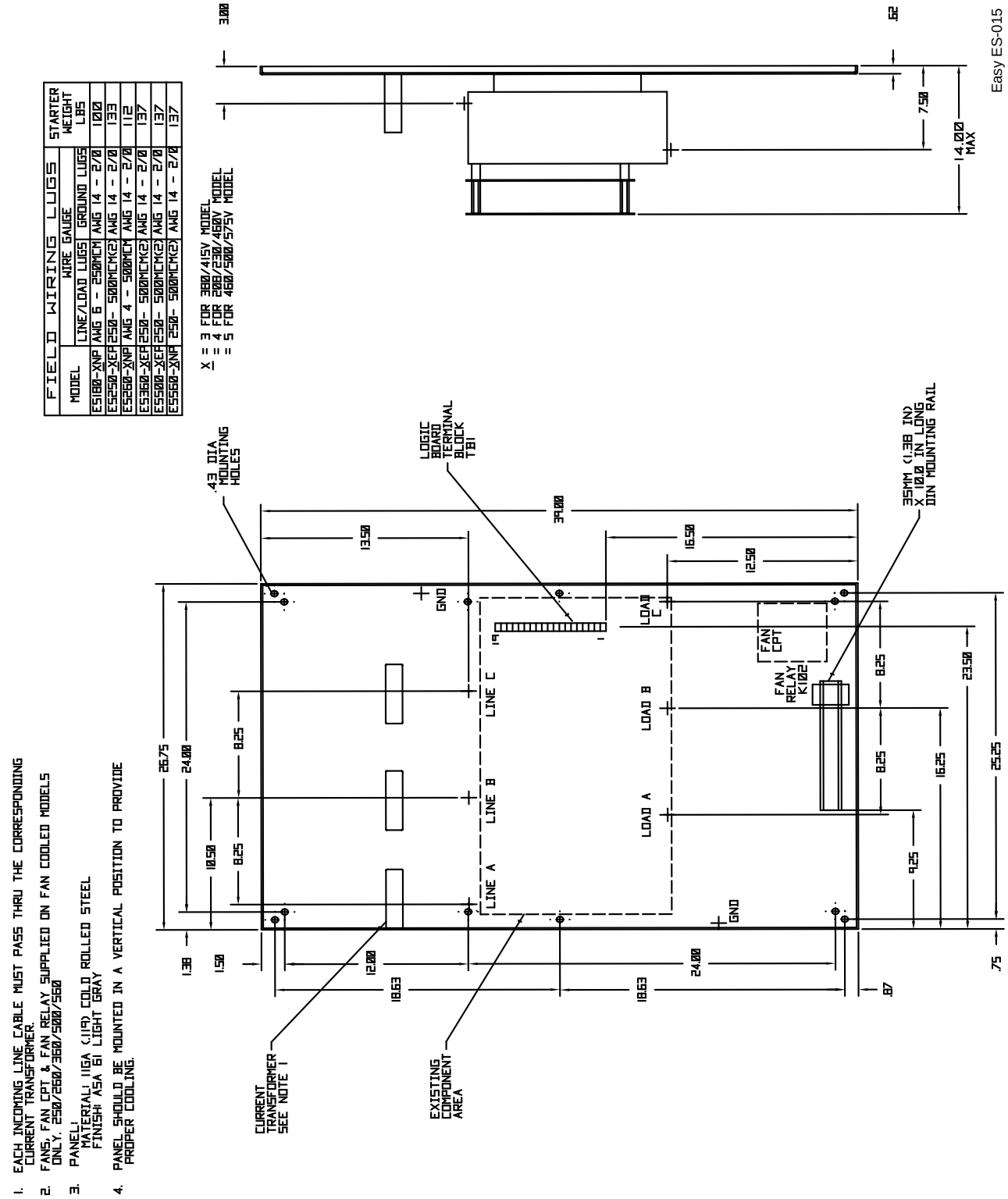
1. WHEN WALL MOUNTING STARTERS SIDE BY SIDE, ALLOW 6 INCHES OF CLEARANCE BETWEEN STARTERS. ALSO ALLOW 6 INCHES CLEARANCE TOP & BOTTOM.
2. LINE LUGS FOR STANDARD STARTER WITHOUT CIRCUIT BREAKER, ARE LOCATED ON PANEL.
3. LINE LUGS WHEN CIRCUIT BREAKER OPTION IS ORDERED ARE LOCATED ON CIRCUIT BREAKER.
4. MAXIMUM RECOMMENDED WIRE GAUGE TO MEET NATIONAL ELECTRIC CODE WIRE BENDING SPACE.
5. ENCLOSURE:
   MATERIAL: 13 GA. (.089") MINIMUM COLD ROLLED STEEL.
   FINISH: ASA 61 LITE GRAY.

MODEL	FIELD WIRING LUGS WIRE GAUGE RANGE LINE/LOAD LUGS	GROUND LUGS	STARTER WEIGHT LBS
ES045-XEL	AWG #14 - #2	AWG #14 - #2	120
ES070-XEL	AWG #14 - #2	AWG #14 - #2	120
ES120-XEL	AWG #14 - 2/0	AWG #14 - 2/0	121

MODEL	CIRCUIT BREAKER OPTION LUGS LINE LUGS WIRE GAUGE RANGE	MAX WIRE GAUGE (SEE NOTE 4)
ES045-XEL	AWG #14 - 1/0	1/0
ES070-XEL	AWG #14 - 4/0	2/0
ES120-XEL	AWG #4 - 350 MCM	2/0

X = 3 FOR 380/415V STARTER
X = 4 FOR 200/230/460V STARTER
X = 5 FOR 460/500/575V STARTER

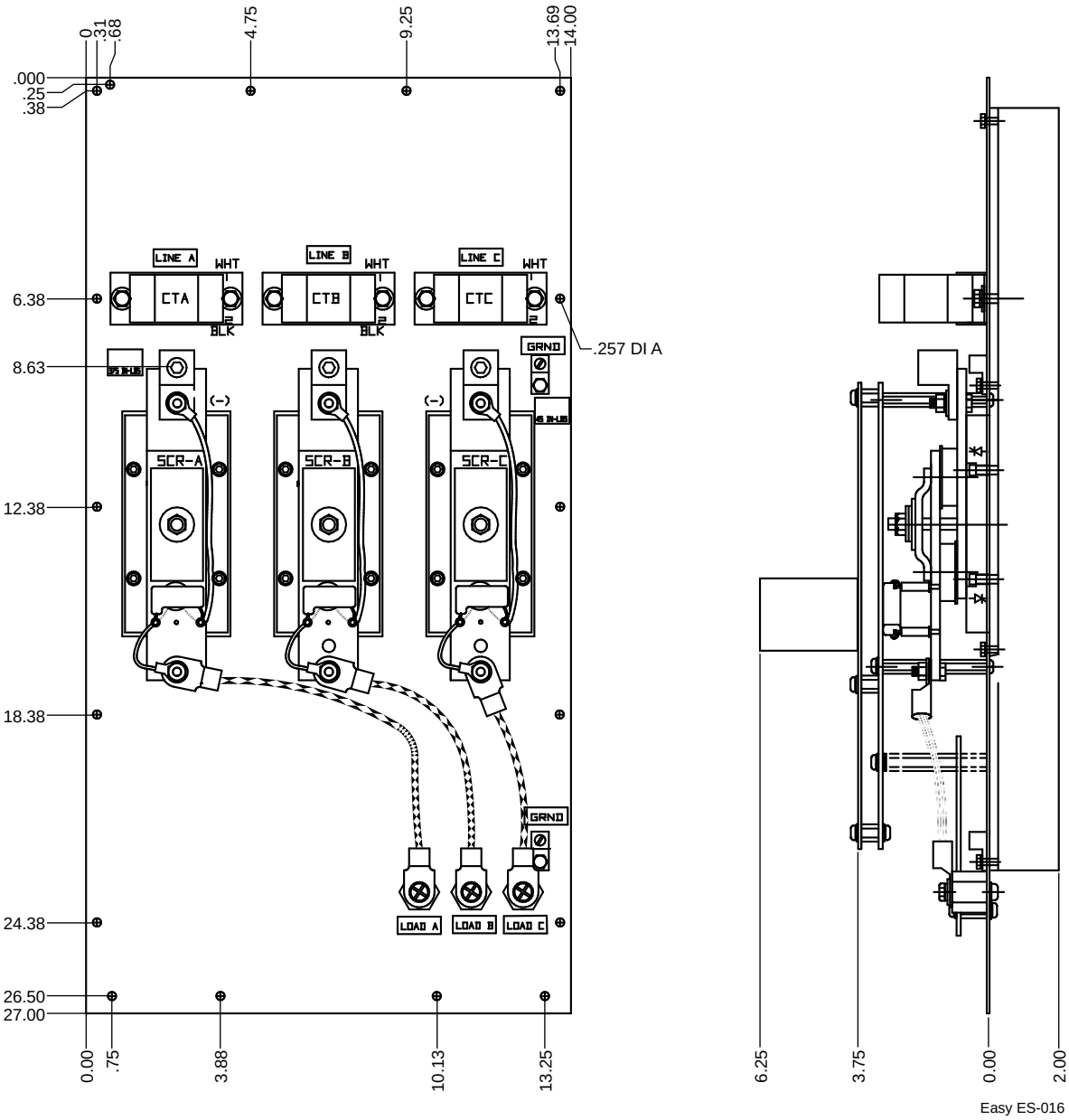
Dimension and Installation NEMA-12 Large Enclosure ES045-_EL, ES070-_EL, ES120-_EL
Figure 2-14


FIELD WIRING LUGS
MODEL
WIRE GAUGE
LINE/LOAD LUGS
GROUND LUGS
STARTER WEIGHT LBS
ES180-XNP AWG 6 - 250MCM AWG 14 - 2/0 100
ES250-XEP 250 - 500MCM(2) AWG 14 - 2/0 133
ES260-XNP AWG 4 - 500MCM AWG 14 - 2/0 112
ES360-XEP 250 - 500MCM(2) AWG 14 - 2/0 137
ES500-XEP 250 - 500MCM(2) AWG 14 - 2/0 137
ES560-XNP 250 - 500MCM(2) AWG 14 - 2/0 137
X = 3 FOR 380/415V MODEL
= 4 FOR 208/230/460V MODEL
= 5 FOR 460/500/575V MODEL
Easy ES-015
.43 DIA MOUNTING HOLES
LOGIC BOARD TERMINAL BLOCK TB1
35MM (1.38 IN) X 100 IN LONG DIN MOUNTING RAIL
FAN CPT
FAN RELAY K102
LINE A
LINE B
LINE C
LOAD A
LOAD B
LOAD C
GND
CURRENT TRANSFORMER SEE NOTE 1
EXISTING COMPONENT AREA
1. EACH INCOMING LINE CABLE MUST PASS THRU THE CORRESPONDING CURRENT TRANSFORMER.
2. FANS, FAN CPT & FAN RELAY SUPPLIED ON FAN COOLED MODELS ONLY. 250/260/360/500/560
3. PANEL:
MATERIAL: 11GA (.119) COLD ROLLED STEEL
FINISH: ASA 61 LIGHT GRAY
4. PANEL SHOULD BE MOUNTED IN A VERTICAL POSITION TO PROVIDE PROPER COOLING.

Dimension and Installation Open Panel ES180-_NP, ES260-_NP, ES560-_NP, ES250-_EP, ES360-_EP, ES500-_EP
Figure 2-15

NOTES
1. EACH INCOMING LINE CABLE MUST PASS THRU THE CORRESPONDING CURRENT TRANSFORMER.
2. PANEL MATERIAL: 14 GA (.074) STEEL
   FINISH: ASA 61 LIGHT GRAY
3. PANEL SHOULD BE MOUNTED IN A VERTICAL POSITION TO PROVIDE PROPER COOLING.
4. USER MUST PROVIDE LOAD LUGS.
5. WHEN DAUGHTER BD. OPTION IS USED DEPTH IS 7.50".

MODEL	FIELD WIRING LUGS		WEIGHT LBS
	WIRE GAUGE RANGE		
	LINE/LUGS	GROUND LUGS	
ES120-_EC	AWG #6-250MCM	AWG 14-2	60

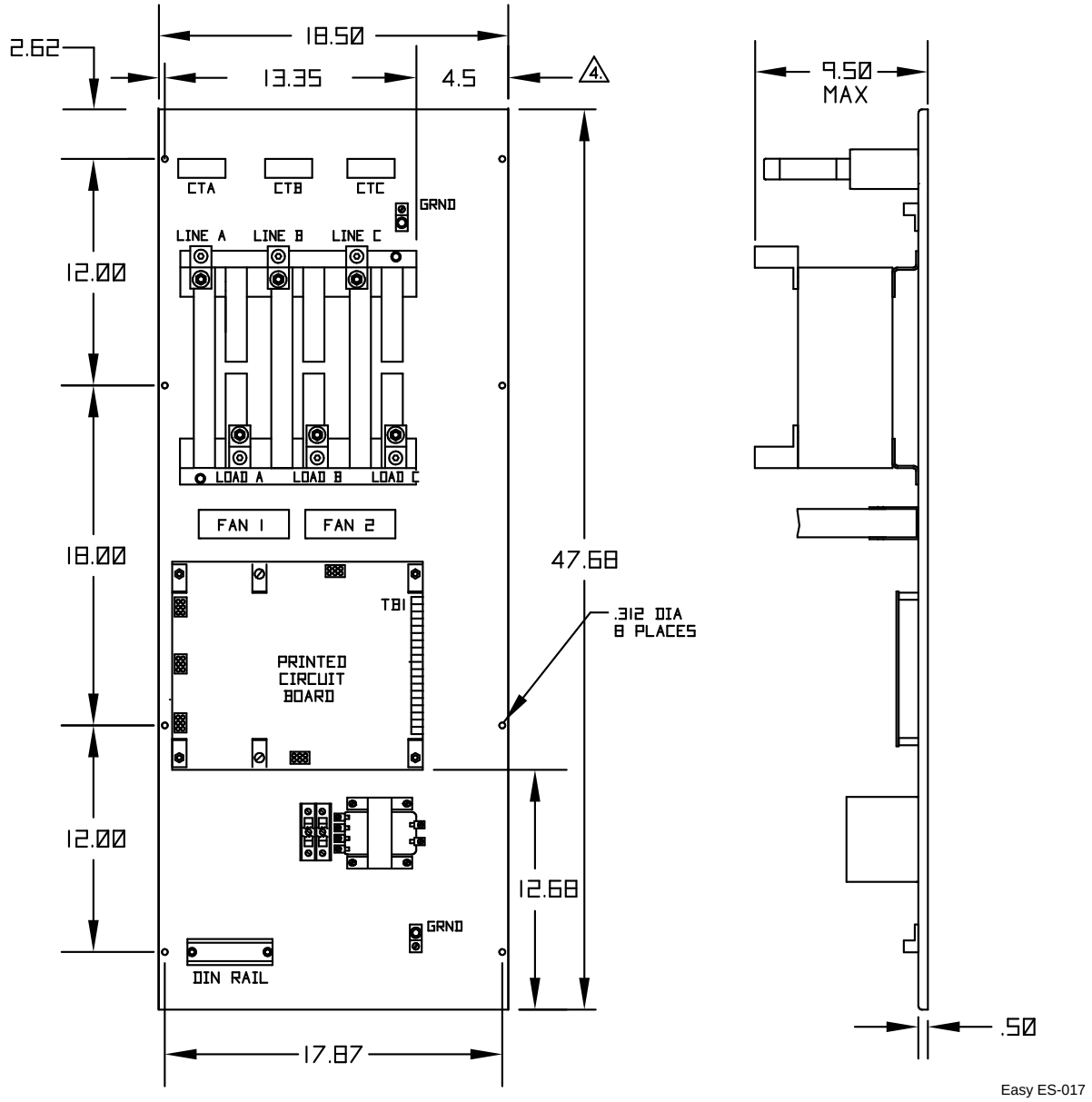


Dimension and Installation Open Panel Slim Line Motor Control Center ES120-_EC
Figure 2-16

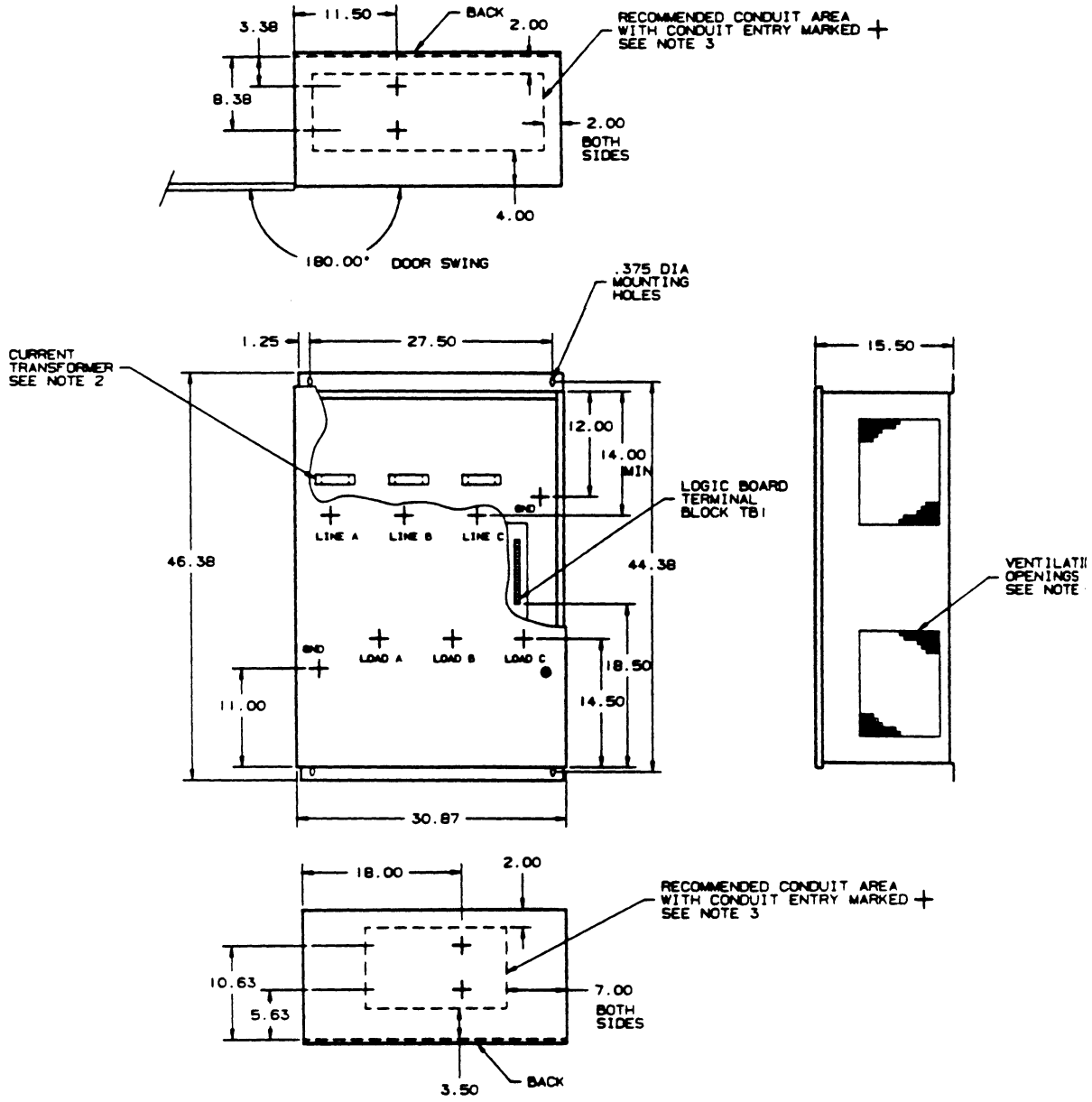
NOTES:

1. EACH INCOMING LINE CABLE MUST PASS THRU THE CORRESPONDING CURRENT TRANSFORMER.
2. PANEL:
   MATERIAL: 12GA (.1046) STEEL
   FINISH: ASA 61 LIGHT GRAY
3. PANEL SHOULD BE MOUNTED IN A VERTICAL POSITION TO PROVIDE PROPER COOLING.
4. 4.5 INCH MINIMUM WIRE AREA

FIELD WIRING LUGS			STARTER WEIGHT LBS
MODEL	WIRE GAUGE		
	LINE/LOAD LUGS	GROUND LUGS	
ES180-_NC	AWG 6-350MCM	AWG 14-2/0	100
ES250-_NC	AWG 6-350MCM	AWG 14-2/0	100



Dimension and Installation Open Panel Slim Line Motor Control Center
ES180-_NC, ES250-_NC
Figure 2-17



NOTES:

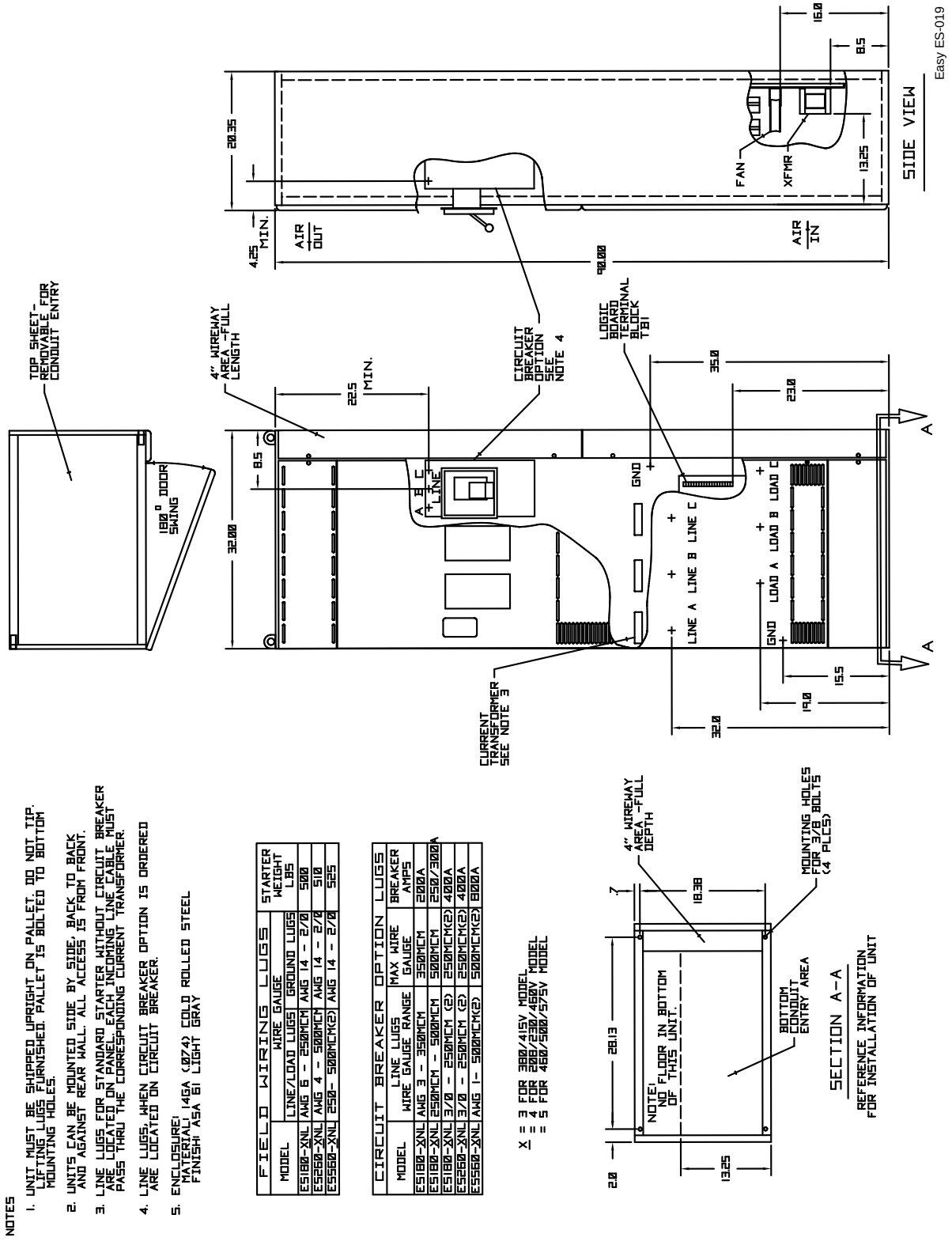
FIELD WIRING LUGS			STARTER WEIGHT LBS
MODEL	WIRE GAUGE		
	LINE/LOAD LUGS	GROUND LUGS	
ES180-XNR	AWG 6 - 250MCM	AWG 14 - 2/0	220
ES260-XNR	AWG 4 - 500MCM	AWG 14 - 2/0	232
ES560-XNR	250- 500MCM(2)	AWG 14 - 2/0	257

X = 3 FOR 380/415V MODEL
= 4 FOR 208/230/460V MODEL
= 5 FOR 460/500/575V MODEL

1. ALLOW 12" MINIMUM CLEARANCE FROM ADJACENT WALL OR NEXT UNIT ON EACH SIDE FOR VENTILATION.
2. EACH INCOMING LINE CABLE MUST PASS THRU THE CORRESPONDIN CURRENT TRANSFORMER.
3. FOR 560A MODEL, WHEN RUNNING TWO 500MCM CABLES PER PHASE, TWO CONDUITS MUST BE USED TO MEET N.E.C. CABLE BENDING SPACE REQUIREMENTS.
4. ENCLOSURE:
   MATERIAL: 13GA (.089) COLD ROLLED STEEL
   FINISH: ASA 61 LIGHT GRAY

Easy ES-018

Dimension and Installation NEMA-1 Regular Enclosure
ES180-_NR, ES260-_NR, ES560-_NR
Figure 2-18



NOTES

1. UNIT MUST BE SHIPPED UPRIGHT ON PALLET. DO NOT TIP. LIFTING LUGS FURNISHED. PALLET IS BOLTED TO BOTTOM MOUNTING HOLES.
2. UNITS CAN BE MOUNTED SIDE BY SIDE, BACK TO BACK AND AGAINST REAR WALL. ALL ACCESS IS FROM FRONT.
3. LINE LUGS FOR STANDARD STARTER WITHOUT CIRCUIT BREAKER ARE LOCATED ON PANEL. EACH INCOMING LINE CABLE MUST PASS THRU THE CORRESPONDING CURRENT TRANSFORMER.
4. LINE LUGS, WHEN CIRCUIT BREAKER OPTION IS ORDERED ARE LOCATED ON CIRCUIT BREAKER.
5. ENCLOSURE:
   MATERIAL: 14GA (.074) COLD ROLLED STEEL
   FINISH: ASA 61 LIGHT GRAY

FIELD WIRING LUGS				STARTER WEIGHT LBS
MODEL	WIRE GAUGE			
	LINE/LOAD LUGS	GROUND LUGS		
ES180-XNL	AWG 6 - 250MCM	AWG 14 - 2/0		500
ES260-XNL	AWG 4 - 500MCM	AWG 14 - 2/0		510
ES560-XNL	250 - 500MCM(2)	AWG 14 - 2/0		525

CIRCUIT BREAKER OPTION LUGS			
MODEL	LINE LUGS WIRE GAUGE RANGE	MAX WIRE GAUGE	BREAKER AMPS
ES180-XNL	AWG 3 - 350MCM	350MCM	200A
ES180-XNL	250MCM - 500MCM	500MCM	250/300A
ES180-XNL	3/0 - 250MCM (2)	250MCM(2)	400A
ES260-XNL	3/0 - 250MCM (2)	250MCM(2)	400A
ES560-XNL	AWG 1- 500MCM(2)	500MCM(2)	800A

X = 3 FOR 380/415V MODEL
= 4 FOR 208/230/460V MODEL
= 5 FOR 460/500/575V MODEL

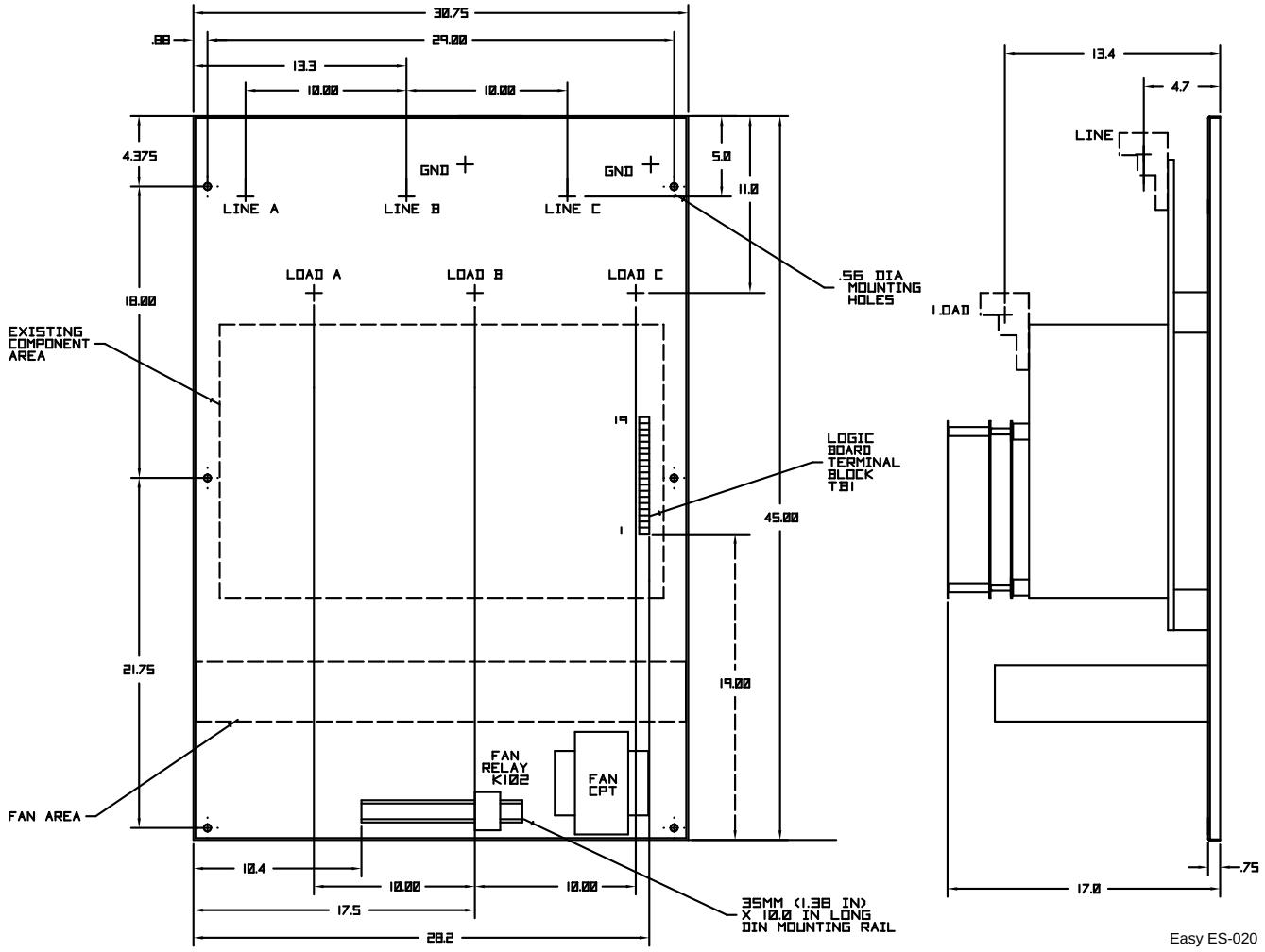
Dimension and Installation NEMA-1 Large Enclosure
ES180-_NL, ES260-_NL, ES560-_NL
Figure 2-19

NOTES:

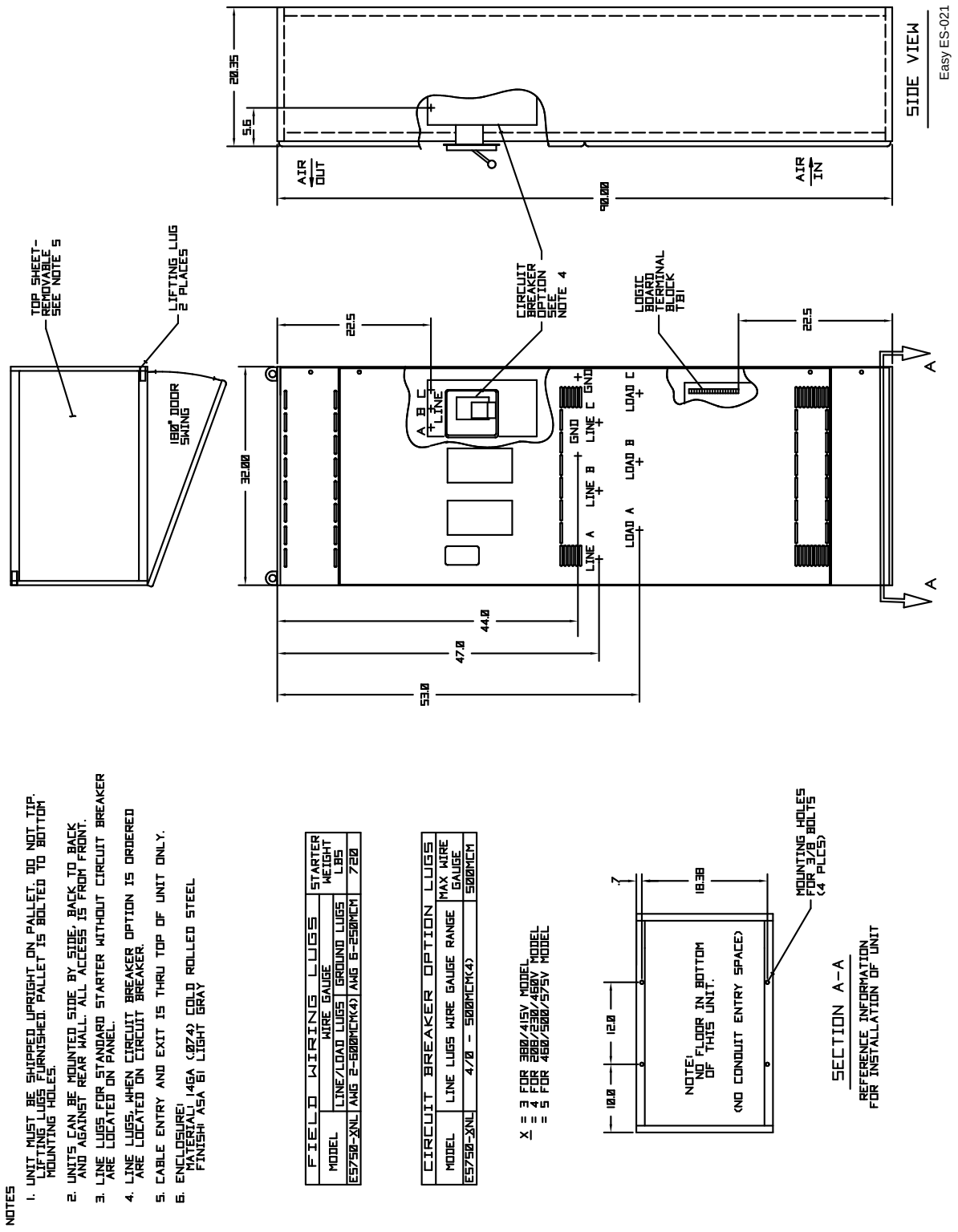
1. PANEL:
   MATERIAL: 11GA (.119) COLD ROLLED STEEL
   FINISH: ASA 61 LIGHT GRAY
2. PANEL SHOULD BE MOUNTED IN A VERTICAL POSITION TO PROVIDE PROPER COOLING.

FIELD WIRING LUGS			STARTER WEIGHT LBS
MODEL	WIRE GAUGE		
	LINE/LOAD LUGS	GROUND LUGS	
ES750-XNP	AWG 2-600MCM(4)	AWG 6-250MCM	320

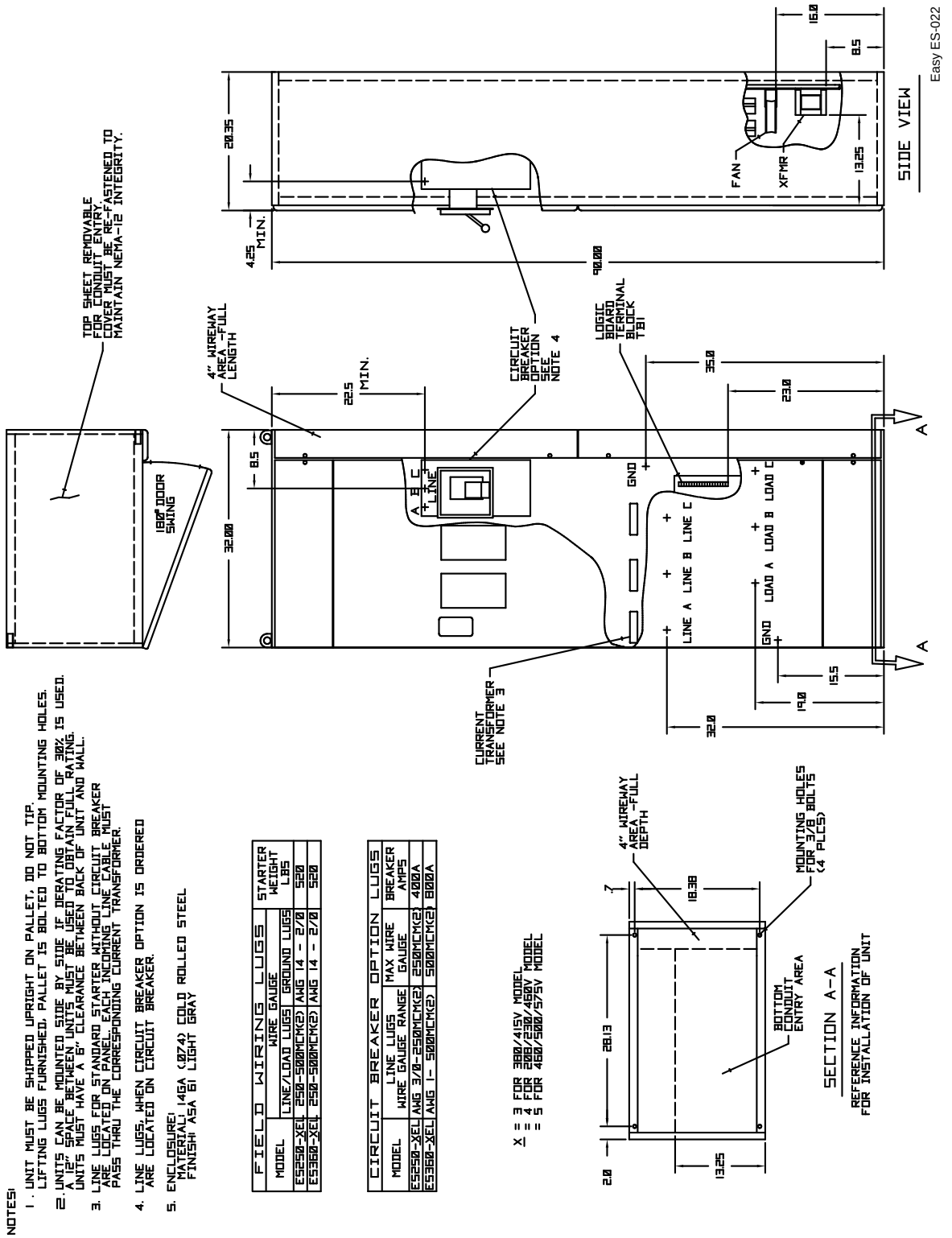
X = 3 FOR 380/415V MODEL
= 4 FOR 208/230/460V MODEL
= 5 FOR 460/500/575V MODEL



Dimension and Installation Open Panel ES750-_NP
Figure 2-20



Dimension and Installation NEMA-1 Large Enclosure ES750-_NL
Figure 2-21


SIDE VIEW
Easy ES-022
TOP SHEET REMOVABLE FOR CONDUIT ENTRY. COVER MUST BE RE-FASTENED TO MAINTAIN NEMA-12 INTEGRITY.
4" WIREWAY AREA -FULL LENGTH
CIRCUIT BREAKER OPTION SEE NOTE 4
LOGIC BOARD TERMINAL BLOCK TB1
CURRENT TRANSFORMER SEE NOTE 3
FAN
XFMR
LINE A LINE B LINE C
LOAD A LOAD B LOAD C
GND
180° DOOR SWING
MOUNTING HOLES FOR 3/8 BOLTS (4 PLCS)
BOTTOM CONDUIT ENTRY AREA
SECTION A-A
REFERENCE INFORMATION FOR INSTALLATION OF UNIT

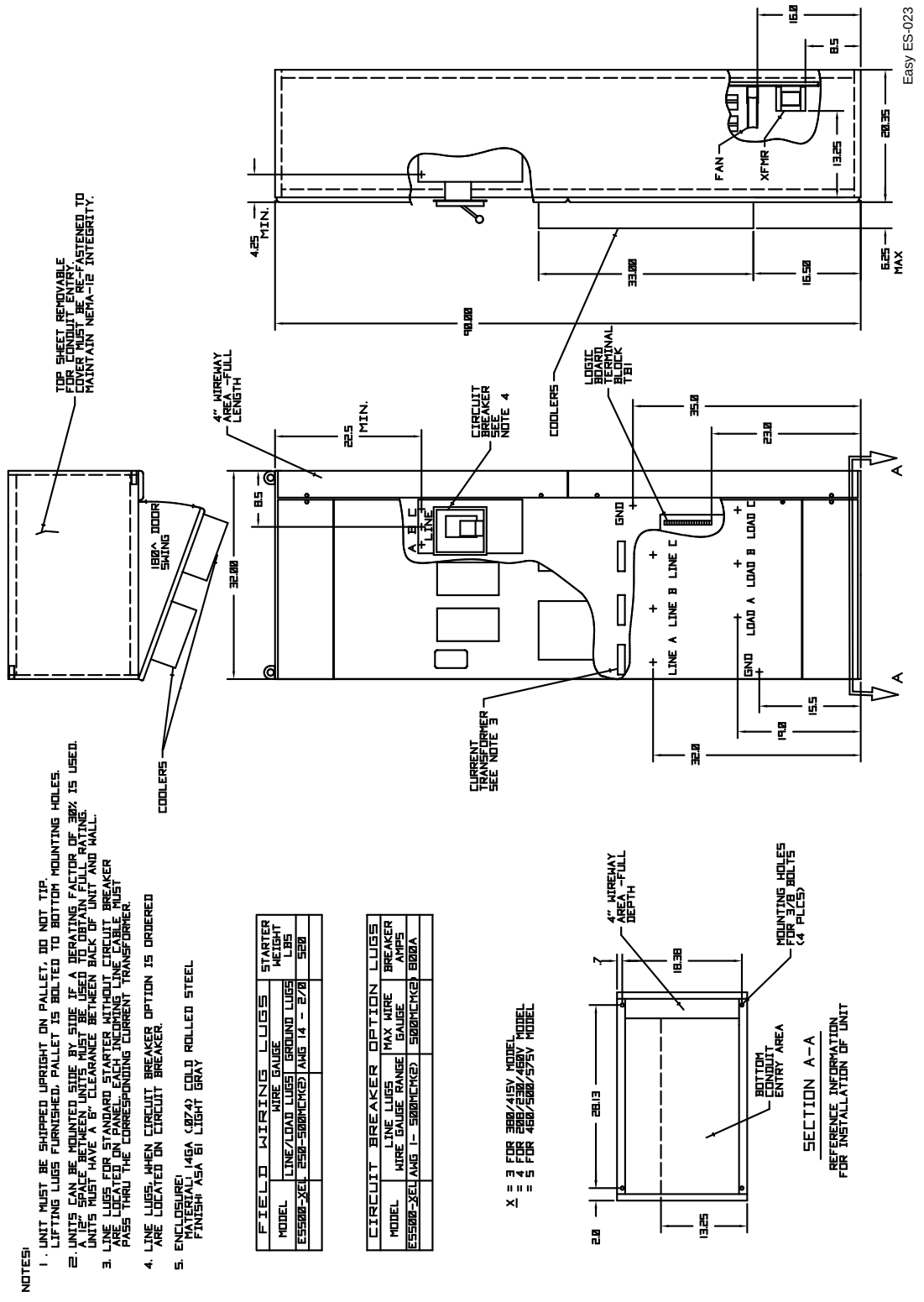
NOTES:
1. UNIT MUST BE SHIPPED UPRIGHT ON PALLET. DO NOT TIP.
   LIFTING LUGS FURNISHED. PALLET IS BOLTED TO BOTTOM MOUNTING HOLES.
2. UNITS CAN BE MOUNTED SIDE BY SIDE IF DERATING FACTOR OF 30% IS USED.
   A 12" SPACE BETWEEN UNITS MUST BE USED TO OBTAIN FULL RATING.
   UNITS MUST HAVE A 6" CLEARANCE BETWEEN BACK OF UNIT AND WALL.
3. LINE LUGS FOR STANDARD STARTER WITHOUT CIRCUIT BREAKER ARE LOCATED ON PANEL. EACH INCOMING LINE CABLE MUST PASS THRU THE CORRESPONDING CURRENT TRANSFORMER.
4. LINE LUGS, WHEN CIRCUIT BREAKER OPTION IS ORDERED ARE LOCATED ON CIRCUIT BREAKER.
5. ENCLOSURE: MATERIAL: 14GA (.074) COLD ROLLED STEEL FINISH: ASA 61 LIGHT GRAY

FIELD WIRING LUGS			STARTER WEIGHT LBS
MODEL	WIRE GAUGE LINE/LOAD LUGS	GROUND LUGS	
ES250-XEL	250-500MCM(2)	AWG 14 - 2/0	520
ES360-XEL	250-500MCM(2)	AWG 14 - 2/0	520

CIRCUIT BREAKER OPTION LUGS			
MODEL	LINE LUGS WIRE GAUGE RANGE	MAX WIRE GAUGE	BREAKER AMPS
ES250-XEL	AWG 3/0-250MCM(2)	250MCM(2)	400A
ES360-XEL	AWG 1- 500MCM(2)	500MCM(2)	800A

X = 3 FOR 380/415V MODEL
X = 4 FOR 208/230/460V MODEL
X = 5 FOR 460/500/575V MODEL

Dimension and Installation NEMA-12 Large Enclosure ES250, ES360-_EL
Figure 2-22


Easy ES-023
TOP SHEET REMOVABLE FOR CONDUIT ENTRY. COVER MUST BE RE-FASTENED TO MAINTAIN NEMA-12 INTEGRITY.
4" WIREWAY AREA -FULL LENGTH
180^ DOOR SWING
COOLERS
CIRCUIT BREAKER SEE NOTE 4
LOGIC BOARD TERMINAL BLOCK TB1
CURRENT TRANSFORMER SEE NOTE 3
FAN
XFMR
LINE A LINE B LINE C
LOAD A LOAD B LOAD C
GND
SECTION A-A
REFERENCE INFORMATION FOR INSTALLATION OF UNIT
4" WIREWAY AREA -FULL DEPTH
MOUNTING HOLES FOR 3/8 BOLTS (4 PLCS)
BOTTOM CONDUIT ENTRY AREA

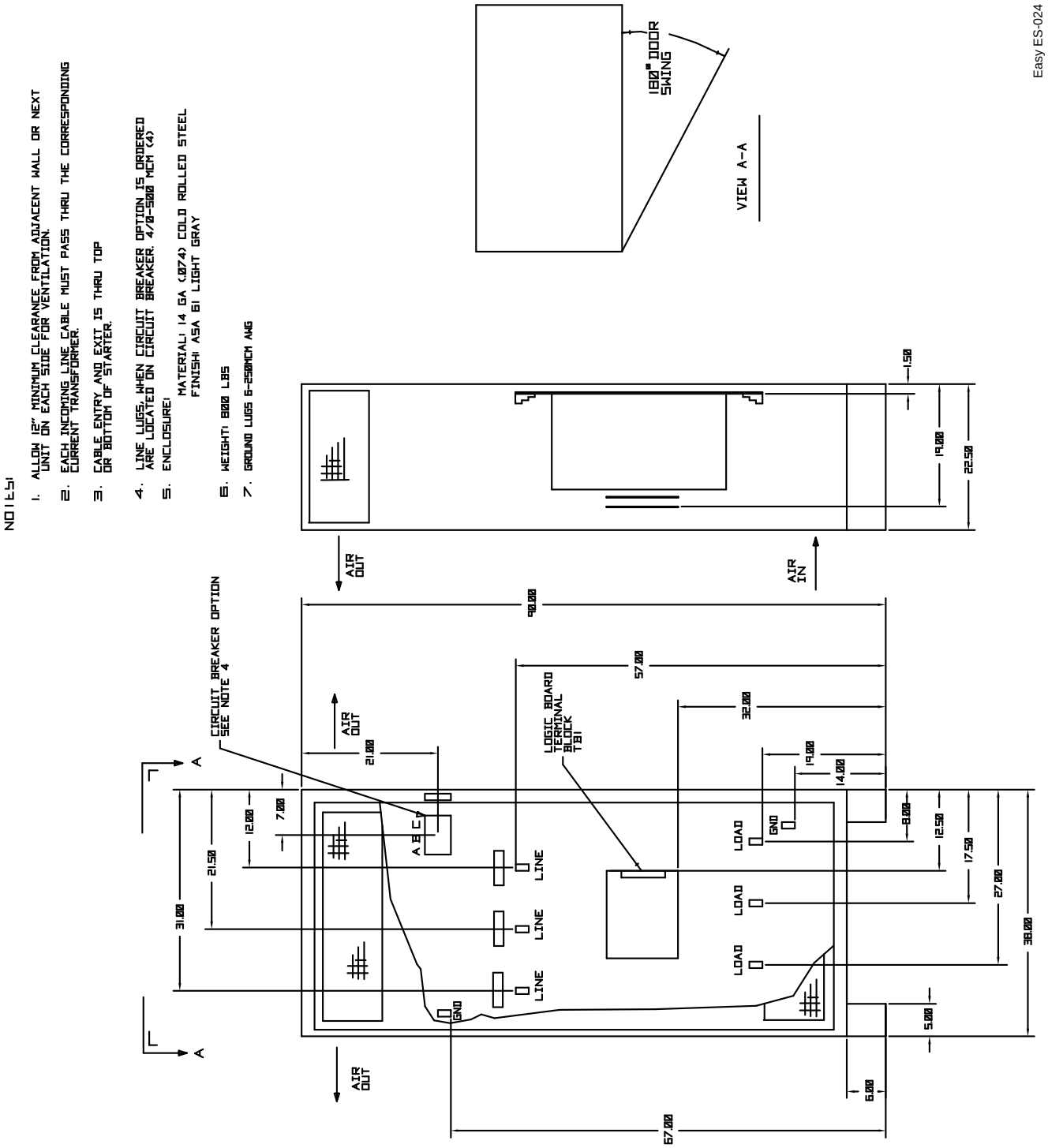
NOTES:
1. UNIT MUST BE SHIPPED UPRIGHT ON PALLET. DO NOT TIP.
   LIFTING LUGS FURNISHED. PALLET IS BOLTED TO BOTTOM MOUNTING HOLES.
2. UNITS CAN BE MOUNTED SIDE BY SIDE IF A DERATING FACTOR OF 30% IS USED.
   A 12" SPACE BETWEEN UNITS MUST BE USED TO OBTAIN FULL RATING.
   UNITS MUST HAVE A 6" CLEARANCE BETWEEN BACK OF UNIT AND WALL.
3. LINE LUGS FOR STANDARD STARTER WITHOUT CIRCUIT BREAKER ARE LOCATED ON PANEL. EACH INCOMING LINE CABLE MUST PASS THRU THE CORRESPONDING CURRENT TRANSFORMER.
4. LINE LUGS, WHEN CIRCUIT BREAKER OPTION IS ORDERED ARE LOCATED ON CIRCUIT BREAKER.
5. ENCLOSURE:
   MATERIAL: 14GA (.074) COLD ROLLED STEEL
   FINISH: ASA 61 LIGHT GRAY

FIELD WIRING LUGS			STARTER WEIGHT LBS
MODEL	WIRE GAUGE		
	LINE/LOAD LUGS	GROUND LUGS	
ES500-_EL	250-500MCM(2)	AWG 14 - 2/0	520

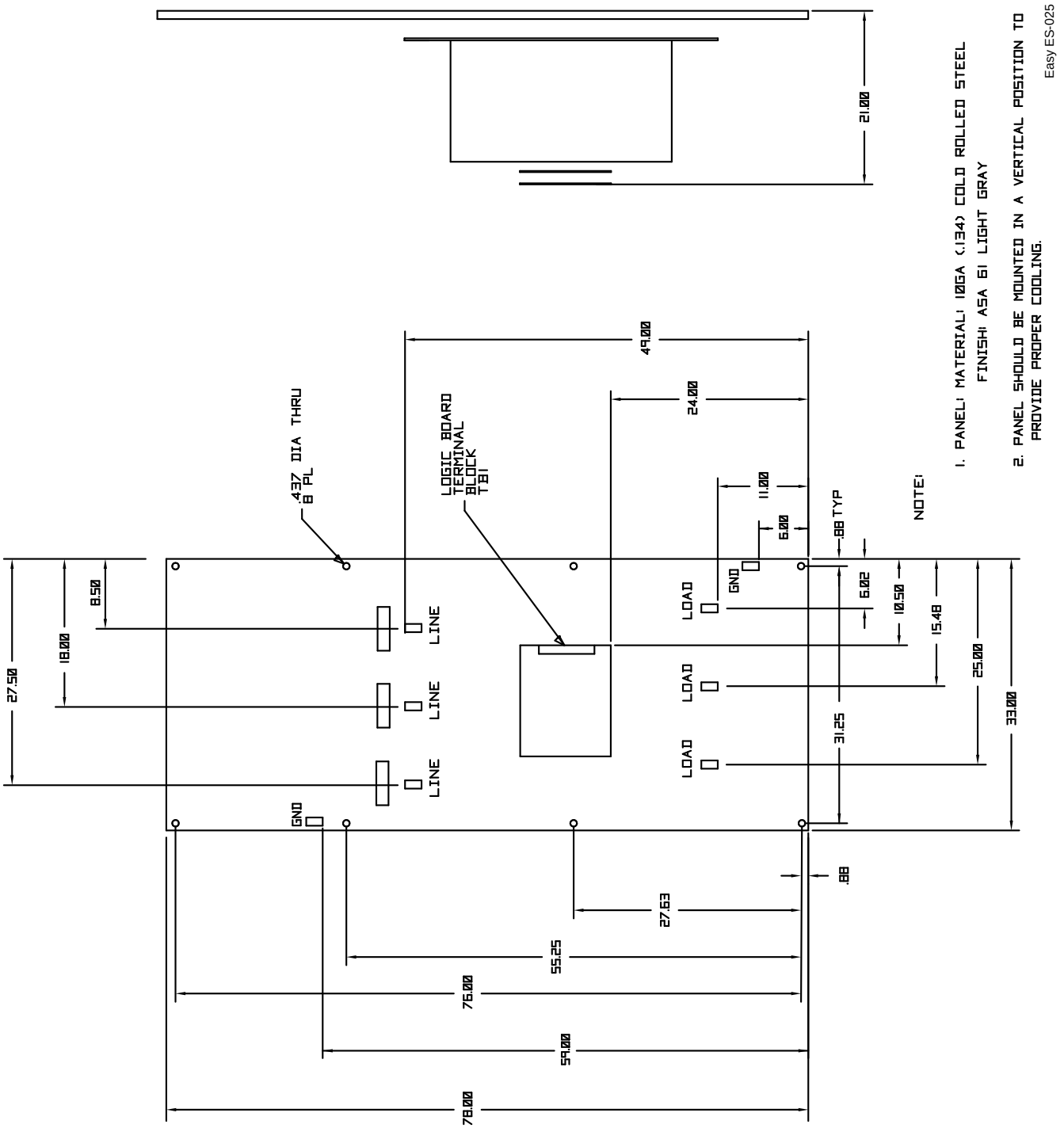
CIRCUIT BREAKER OPTION LUGS			
MODEL	LINE LUGS	MAX WIRE GAUGE	BREAKER AMPS
	WIRE GAUGE RANGE		
ES500-XEL	AWG 1- 500MCM(2)	500MCM(2)	800A

X = 3 FOR 380/415V MODEL
X = 4 FOR 208/230/460V MODEL
X = 5 FOR 460/500/575V MODEL

Dimension and Installation NEMA-12 Large Enclosure ES500-_EL
Figure 2-23



Dimension and Installation NEMA-1 ES950-_NL
Figure 2-24



Dimension and Installation Open Panel ES950-_NP
Figure 2-25

Specifications

This part of the *Installation* section of this Instruction Manual presents the following specifications:

- General Specifications.

Specifications

INSTALLATION

EASY-START ES SPECIFICATIONS:

Current Ratings:

Isolated Sink Suitable for NEMA-12	Non-Isolated Sink Suitable for NEMA-1
45 Amps	180 Amps
70	260
120	560
250	750
500	950

AC Supply Voltage: Three voltage combinations for each current rating:

208/230/460	+10% - 15%	50/60 Hz 3-PH
380/415	+10% - 15%	50/60 Hz 3-PH
460/500/575	+10% - 15%	50/60 Hz 3-PH

Output Stage: 6-SCR's....Full-Wave In-Line Control

Type of Loads: Induction Motor; 3-Wire

Ambient Temperature: Operating range: -20° to +40°C

Ambient Temp Derating: Output rating decreases by 5% for each 5° rise in ambient above 40°, to a maximum of 50°C.

Power Semiconductors:

Starter Voltage Rating:	Current Rating:	
	45-260 Amp	360-950 Amp
208/230/460 Vac	1200 V	1500 V
380/415 Vac	1200 V	1500 V
460/500/575 Vac	1500 V	1500 V

Transient Voltage Suppression: Integral MOV (Metal Oxide Varistor) protects SCR against most short term voltage spikes.

RC Snubber: RC snubber networks prevent false firing of SCR's due to DV/DT characteristics.

Digital Gate Firing: A digital SCR firing trigger provides excellent 3-phase voltage balance between phases.

Electronic Fuse: Instantaneous overcurrent trip circuit will trip out the starter in less than one-cycle with 900% current.

Inverse-Time Current Trip: Overload trip, 3-phase sensing. Operational during start and run. Run-trip adjustable 100-120% see Figure 3-1.

Overload Capacity: Continuous: 120%
30 Seconds: 350%
20 Seconds: 500%

EASY-START ES SPECIFICATIONS:

Starting Current Limit:	Continuous 3-phase sensing, adjustable from 200 to 500%.
Energy Saving:	The Easy-Start ES senses the motor load and slip speed and adjusts the motor voltage to conserve power whenever the motor is lightly loaded.
Power Wiring:	Straight through configuration.
Undervoltage Protection:	Trips at 75% of nominal line voltage. Time delay 2 seconds approximately.
Phase Rotation Protection:	Inhibits starting of motor unless input line voltage is ABC rotation. LED indicates wrong rotation.
Phase-Loss Protection:	Trips if one or more phases are lost. Time delay 0.5 second approximately.
Alarm Relay:	N.O. contact non-isolated, 120 VAC 1 Amp is provided for remote indication of tripped condition.
Auxiliary Contact:	(K2) 1-Form C Isolated, 120 VAC, 5 Amps.
Standard Adjustments:	● Current calibration DIP switches: set at time of installation. See Section 3.
Potentiometer Adjustments: Clockwise rotation increases value.	● Current Trip: 100-120% ● Current Limit: 200500% ● Voltage/Current Ramp: Selectable with switch DS3-1 **Open:** Voltage Ramp Mode **Closed:** Current Ramp Mode ● Ramp Time: 1-40 seconds ● Initial Step: (Torque) Voltage Ramp Mode: 20-90% Current Ramp Mode: 100-200%
Energy-Saving:	● Energy-Saving On/Off: Selectable with switch DS3-2 Open: Energy Saving On Closed: Energy Saving Off
Current Unbalance:	Trips starter off at 20% line current unbalance from the average current.
6-Cycle Delayed Stop:	Phases the SCR's off over a period of approximately 6 line cycles during a normal motor stop command.
5-Cycle Ride-Through:	Starter will retain control of motor during a short line power interruption, when both 3-phase line power and 120 Vac control power are lost.
Overtemperature Protection:	Thermostat sensors, on heat sinks of fan cooled starters activate and shut down starter in case of high ambient or lack of proper air flow.

SECTION 3
Operation

About This Section

This section of the Instruction Manual provides information about the operation of the Easy-Start ES solid state reduced voltage motor starter. After you review this section you will understand:

- Operation of the Easy-Start ES Motor Starter.
- Adjustments.

⚠ Caution

Make sure you read, understand and follow all of the Safety Statements in the Safety section of this guide and all of the operation instructions in this manual ***before*** you operate your Adjustable Frequency Drive.

Operation

There are primarily two basic modes of operation.

1. **Voltage Ramp** - The motor voltage is increased linearly from an initial step voltage, until it reaches full line voltage. This is done by the use of the two adjustments, time and initial step. The initial step adjustment is used to get the motor turning upon a start command.

   At very low initial step voltage settings, the motor may not begin to turn for several seconds.

   For true voltage time-ramp operation, the current limit should be set to its maximum value ie. 500%, in this manner the current limit is only used as an over-ride feature and provides a safeguard from overcurrent.

2. **Current Ramp** - This type of operation provides a motor current profile that starts with an initial step of current, and then ramps up linearly to a level which can be set by the current limit adjustment.

   This type of operation is recommended for most high inertia loads since the motor speed generally responds better with a current ramp than it does with a voltage ramp.

In both the above modes of operation, the current limit remains in the circuit to over-ride the ramp. The current limit is adjustable from 200 to 500%. A precaution must be advised here, that if the current limit is adjusted too low, the motor may start to rotate, but never reach rated speed. This may cause the electronic current over-load to trip; see Figure 3-1.

Adjustments

1. ***Current Calibration DIP Switches (DS1, DS2) work together as follows:***

   DS1 is active all the time. ***DS2 is only in the circuit whenever a connection is made between TB1-2 and TB1-8 on the main logic board***. If a relay is used, it should have dry contacts. If this connection is not made, DS2 reverts to "000" setting, and therefore we use only the DS1 settings and the 1st column of multipliers from 0.282 to 1.00; (see Table 3-1). When a connection is made between TB1-2 and TB1-8, this gives us 128 possible settings and extends the current range to approximately 7:1.

   The DIP switch current settings depend on the CT used with the starter. The maximum ampere setting is 1/6 of the CT rating.

Easy-Start ES Models and CT Ratings

MODEL NO.	RATING AMPS	CT
ES045-E	45	270:1
ES070-E	70	420:1
ES120-E	120	720:1
ES180-N	180	1080:1
ES250-E	250	1500:1
ES260-N	260	1560:1
ES360	360	2160:1
ES500	500	3000:1
ES560-N	560	3360:1
ES750-N	750	4500:1
ES950-N	950	5700:1

Examples: (Using NEMA-12 Model ES250)

Example - 1 200 HP 235 FLA: To find the multiplier divide 235/250=0.940 From tables use multiplier that is equal or slightly less than 0.940 (use 0.934 DS1="1101" DS2="000") this gives us 0.934 x 250 = 234 amps.

Example - 2 100 HP 117 FLA: Multiplier = 117/250 = 0.468 (we select 0.460 DS1="1001" and DS2="111") this gives us 0.460 x 250=115 amps. In order to activate DS2, connect TB1-2 to TB1-8 on the logic board.

DIP Switch Code: OPEN = 0 CLOSED = 1

DIP Switch Settings

DS1 POSITIONS				DS2							
				123	123	123	123	123	123	123	123
1	2	3	4	000	001	010	011	100	101	110	111
0	0	0	0	0.282	0.247	0.223	0.201	0.179	0.164	0.153	0.142
0	0	0	1	0.364	0.321	0.291	0.263	0.234	0.215	0.202	0.187
0	0	1	0	0.432	0.382	0.348	0.315	0.282	0.260	0.243	0.227
0	0	1	1	0.501	0.445	0.407	0.369	0.331	0.306	0.287	0.268
0	1	0	0	0.544	0.485	0.444	0.404	0.363	0.336	0.316	0.295
0	1	0	1	0.605	0.541	0.497	0.454	0.408	0.379	0.356	0.333
0	1	1	0	0.656	0.589	0.542	0.496	0.448	0.416	0.392	0.367
0	1	1	1	0.709	0.640	0.589	0.540	0.489	0.455	0.430	0.403
1	0	0	0	0.743	0.672	0.620	0.570	0.516	0.481	0.454	0.426
1	0	0	1	0.790	0.717	0.663	0.611	0.555	0.517	0.489	0.460
1	0	1	0	0.830	0.754	0.700	0.646	0.558	0.549	0.520	0.489
1	0	1	1	0.871	0.794	0.738	0.682	0.623	0.583	0.552	0.520
1	1	0	0	0.897	0.819	0.762	0.706	0.645	0.604	0.572	0.540
1	1	0	1	0.934	0.856	0.798	0.740	0.677	0.635	0.602	0.569
1	1	1	0	0.967	0.888	0.829	0.770	0.706	0.663	0.630	0.595
1	1	1	1	1.000	0.920	0.860	0.801	0.736	0.692	0.658	0.622

DIP Switch Setting Multipliers
Table 3-1

DIP Switch Settings

For complete DIP switch calibration AC current tables of all Models, see the following tables (Tables 3-2 thru 3-12).

DS1 POSITIONS				DS2							
				123	123	123	123	123	123	123	123
1	2	3	4	000	001	010	011	100	101	110	111
0	0	0	0	12.7	11.1	10.1	9.0	8.0	7.4	6.9	6.4
0	0	0	1	16.4	14.4	13.1	11.8	10.5	9.7	9.1	8.4
0	0	1	0	19.4	17.2	15.6	14.2	12.7	11.7	10.9	10.2
0	0	1	1	22.5	20.0	18.3	16.6	14.9	13.8	12.9	12.1
0	1	0	0	25.5	21.8	20.0	18.2	16.3	15.1	14.2	13.3
0	1	0	1	27.2	24.4	22.4	20.4	18.4	17.0	16.0	15.0
0	1	1	0	29.5	26.5	24.4	22.3	20.2	18.7	17.6	16.5
0	1	1	1	31.9	28.8	26.5	24.3	22.0	20.5	19.3	18.1
1	0	0	0	33.4	30.2	27.9	25.6	23.2	21.7	20.4	19.2
1	0	0	1	35.6	32.2	29.8	27.5	25.0	23.3	22.0	20.7
1	0	1	0	37.4	34.0	31.5	29.1	26.5	24.7	23.4	22.0
1	0	1	1	39.2	35.7	33.2	30.7	28.0	26.2	24.8	23.4
1	1	0	0	40.4	36.9	34.3	31.8	29.0	27.2	25.8	24.3
1	1	0	1	42.0	38.5	35.9	33.3	30.5	28.6	27.1	25.6
1	1	1	0	43.5	39.9	37.3	34.6	31.8	29.9	28.2	26.8
1	1	1	1	45.0	41.4	38.7	36.0	33.1	31.1	29.6	28.0

DIP Switch Ampere Settings ES045
Table 3-2

DIP Switch Settings

DS1 POSITIONS				DS2							
				123	123	123	123	123	123	123	123
1	2	3	4	000	001	010	011	100	101	110	111
0	0	0	0	19.7	17.3	15.6	14.1	12.5	11.5	10.7	9.9
0	0	0	1	25.5	22.4	20.4	18.4	16.4	15.1	14.1	13.1
0	0	1	0	30.2	26.8	24.3	22.0	19.7	18.2	17.0	15.9
0	0	1	1	35.1	31.2	28.5	25.8	23.2	21.4	20.1	18.8
0	1	0	0	38.1	34.0	31.1	28.3	25.4	23.5	22.1	20.6
0	1	0	1	42.4	37.9	34.8	31.8	28.6	26.5	24.9	23.3
0	1	1	0	45.9	41.2	37.9	34.7	31.4	29.1	27.4	25.7
0	1	1	1	49.6	44.8	41.2	37.8	34.2	31.9	30.1	28.2
1	0	0	0	52.0	47.0	43.4	39.9	36.1	33.7	31.8	29.9
1	0	0	1	55.3	50.2	46.4	42.7	38.8	36.2	34.2	32.2
1	0	1	0	58.1	52.8	49.0	45.2	41.2	38.5	36.4	34.2
1	0	1	1	61.0	55.6	51.6	47.7	43.6	40.8	38.7	36.4
1	1	0	0	62.8	57.3	53.4	49.4	45.1	42.3	40.1	37.8
1	1	0	1	65.4	59.9	55.8	51.8	47.4	44.5	42.2	39.8
1	1	1	0	67.7	62.1	58.0	53.9	49.4	46.4	44.1	41.6
1	1	1	1	70.0	64.4	60.2	56.1	51.5	48.4	46.1	43.5

DIP Switch Ampere Settings ES070
Table 3-3

DS1 POSITIONS				DS2							
				123	123	123	123	123	123	123	123
1	2	3	4	000	001	010	011	100	101	110	111
0	0	0	0	33.8	29.6	26.8	24.1	21.4	19.7	18.4	17.1
0	0	0	1	43.7	38.5	34.9	31.5	28.1	25.9	24.2	22.5
0	0	1	0	51.8	45.9	41.7	37.8	33.8	31.2	29.2	27.2
0	0	1	1	60.1	53.4	48.8	44.3	39.7	36.7	34.4	32.2
0	1	0	0	65.3	58.2	53.3	48.4	43.5	40.3	37.9	35.4
0	1	0	1	72.6	65.0	59.6	54.5	49.0	45.4	42.8	40.0
0	1	1	0	78.7	70.7	65.0	59.5	53.8	49.9	47.0	44.0
0	1	1	1	85.1	76.7	70.7	64.8	58.7	54.6	51.6	48.3
1	0	0	0	89.2	80.6	74.4	68.4	62.0	57.8	54.5	51.2
1	0	0	1	94.8	86.0	79.5	73.3	66.5	62.1	58.7	55.2
1	0	1	0	99.6	90.5	84.0	77.5	70.6	65.9	62.3	58.7
1	0	1	1	104.5	95.3	88.5	81.8	74.7	69.9	66.3	62.4
1	1	0	0	107.6	98.3	91.5	84.7	77.4	72.4	68.7	64.8
1	1	0	1	112.1	102.7	95.7	88.8	81.3	76.2	72.3	68.3
1	1	1	0	116.0	106.5	99.4	92.4	84.7	79.6	75.5	71.4
1	1	1	1	120.0	110.4	103.2	96.1	88.3	83.0	79.0	74.6

DIP Switch Ampere Settings ES120
Table 3-4

DIP Switch Settings

DS1 POSITIONS				DS2							
1	2	3	4	123 000	123 001	123 010	123 011	123 100	123 101	123 110	123 111
0	0	0	0	50.8	44.5	40.2	36.2	32.1	29.5	27.6	25.6
0	0	0	1	65.5	57.7	52.4	47.3	42.1	38.8	36.3	33.7
0	0	1	0	77.8	68.8	62.6	56.7	50.7	46.7	43.8	40.8
0	0	1	1	90.2	80.2	73.2	66.5	59.6	55.1	51.7	48.2
0	1	0	0	97.9	87.3	79.9	72.7	65.3	60.4	56.8	53.1
0	1	0	1	108.9	97.5	89.4	81.7	73.5	68.2	64.1	60.0
0	1	1	0	118.1	106.0	97.5	89.3	80.6	74.9	70.5	66.0
0	1	1	1	127.6	115.1	106.1	97.2	88.1	81.9	77.3	72.5
1	0	0	0	133.7	120.9	111.7	102.6	92.9	86.7	81.7	76.8
1	0	0	1	142.2	129.0	119.3	109.9	99.8	93.1	88.0	82.8
1	0	1	0	149.4	135.8	125.9	116.2	105.9	98.9	93.5	88.0
1	0	1	1	156.8	143.0	132.8	122.8	112.1	104.9	99.4	93.6
1	1	0	0	161.5	147.4	137.2	127.1	116.1	108.7	103.0	97.2
1	1	0	1	168.1	154.0	143.6	133.2	121.9	114.3	108.4	102.4
1	1	1	0	174.1	159.8	149.2	138.6	127.1	119.4	113.3	107.0
1	1	1	1	180.0	165.6	154.8	144.2	132.5	124.6	118.4	112.0

DIP Switch Ampere Settings ES180
Table 3-5

DS1 POSITIONS				DS2							
1	2	3	4	123 000	123 001	123 010	123 011	123 100	123 101	123 110	123 111
0	0	0	0	70.5	61.8	55.8	50.3	44.6	41.0	38.3	35.5
0	0	0	1	91.0	80.2	72.7	65.7	58.5	53.9	50.4	46.9
0	0	1	0	108.0	95.6	86.9	78.7	70.4	64.9	60.8	56.7
0	0	1	1	125.3	111.3	101.7	92.3	82.8	76.5	71.8	67.0
0	1	0	0	136.0	121.3	111.0	100.9	90.7	83.9	78.9	73.7
0	1	0	1	151.3	135.4	124.2	113.4	102.1	94.7	89.1	83.3
0	1	1	0	164.0	147.3	135.5	124.0	112.0	104.0	97.9	91.7
0	1	1	1	177.3	159.9	147.3	135.1	122.3	113.8	107.4	100.7
1	0	0	0	185.8	167.9	155.1	142.5	129.1	120.4	113.5	106.6
1	0	0	1	197.5	179.1	165.7	152.7	138.6	129.4	122.3	114.9
1	0	1	0	207.5	188.6	174.9	161.4	147.1	137.4	129.9	122.2
1	0	1	1	217.8	198.6	184.4	170.5	155.7	145.7	138.1	130.0
1	1	0	0	224.3	204.7	190.6	176.5	161.2	150.9	143.1	135.0
1	1	0	1	233.5	213.9	199.4	184.9	169.3	158.8	150.6	142.2
1	1	1	0	241.8	221.9	207.2	192.4	176.5	165.8	157.4	148.7
1	1	1	1	250.0	230.0	215.0	200.3	184.0	173.0	164.5	155.5

DIP Switch Ampere Settings ES250
Table 3-6

DIP Switch Settings

DS1 POSITIONS				DS2							
				123	123	123	123	123	123	123	123
1	2	3	4	000	001	010	011	100	101	110	111
0	0	0	0	73.3	64.2	58.1	52.3	46.4	42.6	39.8	37.0
0	0	0	1	94.6	83.4	75.6	68.3	60.9	56.0	52.4	48.7
0	0	1	0	112.3	99.4	90.4	81.9	73.2	67.5	63.2	59.0
0	0	1	1	130.3	115.8	105.8	96.0	86.1	79.6	74.6	69.7
0	1	0	0	141.4	126.2	115.4	104.9	94.3	87.3	82.0	76.7
0	1	0	1	157.3	140.8	129.1	118.0	106.2	98.5	92.6	86.7
0	1	1	0	170.6	153.2	140.9	128.9	116.5	108.1	101.8	95.3
0	1	1	1	184.3	166.3	153.2	140.5	127.2	118.3	111.7	104.7
1	0	0	0	193.2	174.6	161.3	148.2	134.3	125.2	118.0	110.9
1	0	0	1	205.4	186.3	172.3	158.8	144.2	134.5	127.1	119.5
1	0	1	0	215.8	196.2	181.9	167.9	153.0	142.9	135.1	127.1
1	0	1	1	226.5	206.5	191.8	177.3	161.9	151.5	143.6	135.2
1	1	0	0	233.2	212.9	198.2	183.5	167.7	157.0	148.8	140.4
1	1	0	1	242.8	222.4	207.4	192.3	176.1	165.1	156.6	147.9
1	1	1	0	251.4	230.8	215.5	200.1	183.5	172.5	163.7	154.6
1	1	1	1	260.0	239.2	223.6	208.3	191.4	179.9	171.1	161.7

DIP Switch Ampere Settings ES260
Table 3-7

DS1 POSITIONS				DS2							
				123	123	123	123	123	123	123	123
1	2	3	4	000	001	010	011	100	101	110	111
0	0	0	0	101.5	88.9	80.4	72.4	64.3	59.0	55.1	51.2
0	0	0	1	131.0	115.4	104.7	94.6	84.3	77.6	72.6	67.5
0	0	1	0	155.5	137.6	125.2	113.4	101.4	93.5	87.6	81.6
0	0	1	1	180.4	160.3	146.5	132.9	119.2	110.2	103.3	96.5
0	1	0	0	195.8	174.7	159.8	145.3	130.6	120.8	113.6	106.1
0	1	0	1	217.8	194.9	178.8	163.4	147.0	136.3	128.3	120.0
0	1	1	0	236.2	212.1	195.1	178.5	161.3	149.7	141.0	132.0
0	1	1	1	255.2	230.2	212.1	194.5	176.1	163.9	154.7	145.0
1	0	0	0	267.5	241.8	223.3	205.2	185.9	173.3	163.4	153.5
1	0	0	1	284.4	258.0	238.6	219.8	199.6	186.3	176.0	165.5
1	0	1	0	298.8	271.6	251.9	232.5	211.8	197.8	187.0	176.0
1	0	1	1	313.6	286.0	265.6	245.5	224.2	209.8	198.8	187.2
1	1	0	0	322.9	294.8	274.5	254.1	232.2	217.3	206.0	194.4
1	1	0	1	336.2	308.0	287.1	266.3	243.8	228.6	216.9	204.8
1	1	1	0	348.1	319.6	298.3	277.1	254.1	238.8	226.6	214.1
1	1	1	1	360.0	331.2	309.6	288.4	265.0	249.1	236.9	223.9

DIP Switch Ampere Settings ES360
Table 3-8

DIP Switch Settings

DS1 POSITIONS				DS2							
1	2	3	4	123 000	123 001	123 010	123 011	123 100	123 101	123 110	123 111
0	0	0	0	141.0	123.5	111.7	100.5	89.3	81.9	76.6	71.1
0	0	0	1	182.0	160.3	145.4	131.4	117.0	107.7	100.8	93.7
0	0	1	0	216.0	191.2	173.9	157.5	140.8	129.8	121.6	113.4
0	0	1	1	250.5	222.7	203.4	184.6	165.6	153.1	143.5	134.0
0	1	0	0	272.0	242.6	222.0	201.8	181.4	167.8	157.8	147.4
0	1	0	1	302.5	270.7	248.4	226.9	204.2	189.4	178.2	166.7
0	1	1	0	328.0	294.5	270.9	248.0	224.0	208.0	195.8	183.4
0	1	1	1	354.5	319.8	294.6	270.1	244.6	227.6	214.8	201.4
1	0	0	0	371.5	335.8	310.2	284.9	258.2	240.7	227.0	213.2
1	0	0	1	395.0	358.3	331.4	305.3	277.3	258.7	244.5	229.9
1	0	1	0	415.0	377.2	349.8	322.9	294.2	274.7	259.8	244.4
1	0	1	1	435.5	397.2	368.9	341.0	311.4	291.3	276.1	260.0
1	1	0	0	448.5	409.5	381.2	353.0	322.5	301.8	286.1	270.0
1	1	0	1	467.0	427.8	398.8	369.9	338.6	317.6	301.2	284.4
1	1	1	0	483.5	443.9	414.4	384.9	353.0	331.7	314.8	297.4
1	1	1	1	500.0	460.0	430.0	400.5	368.0	346.0	329.0	311.0

DIP Switch Ampere Settings ES500
Table 3-9

DS1 POSITIONS				DS2							
1	2	3	4	123 000	123 001	123 010	123 011	123 100	123 101	123 110	123 111
0	0	0	0	157.9	138.3	125.1	112.6	100.0	91.8	85.8	79.6
0	0	0	1	203.8	179.6	162.9	147.2	131.1	120.7	112.9	105.0
0	0	1	0	241.9	214.1	194.7	176.4	157.7	145.4	136.2	127.0
0	0	1	1	280.6	249.4	227.8	206.8	185.5	171.4	160.8	150.1
0	1	0	0	304.6	271.7	248.6	226.0	203.2	188.0	176.7	165.1
0	1	0	1	338.8	303.2	278.2	254.1	228.7	212.1	199.6	186.7
0	1	1	0	367.4	329.9	303.4	277.7	250.9	232.9	219.3	205.4
0	1	1	1	397.0	358.1	329.9	302.5	274.0	254.9	240.6	225.5
1	0	0	0	416.1	376.1	347.4	319.1	289.2	269.6	254.2	238.8
1	0	0	1	442.4	401.3	371.2	342.0	310.6	289.8	273.8	257.5
1	0	1	0	464.8	422.5	391.8	361.6	329.5	307.7	291.0	273.8
1	0	1	1	487.8	444.8	413.1	381.9	348.7	326.3	309.2	291.2
1	1	0	0	502.3	458.6	427.0	395.3	361.2	338.1	320.5	302.4
1	1	0	1	523.0	479.1	446.7	414.2	379.2	355.7	337.4	318.5
1	1	1	0	541.5	497.1	464.1	431.0	395.3	371.5	352.5	333.0
1	1	1	1	560.0	515.2	481.6	448.6	412.2	387.5	368.5	348.3

DIP Switch Ampere Settings ES560
Table 3-10

DIP Switch Settings

DS1 POSITIONS				DS2							
				123	123	123	123	123	123	123	123
1	2	3	4	000	001	010	011	100	101	110	111
0	0	0	0	211.5	185.3	167.5	150.8	133.9	122.9	114.8	106.6
0	0	0	1	273.0	240.5	218.1	197.1	175.5	161.6	151.2	140.6
0	0	1	0	324.0	286.7	260.8	236.2	211.2	194.7	182.4	170.1
0	0	1	1	375.8	334.0	305.1	276.9	248.4	229.6	215.3	201.0
0	1	0	0	408.0	363.9	332.9	302.7	272.1	251.7	236.6	221.1
0	1	0	1	453.8	406.1	372.5	340.3	306.3	284.0	267.3	250.0
0	1	1	0	492.0	441.8	406.4	372.0	336.0	311.9	293.7	275.0
0	1	1	1	531.8	479.6	441.9	405.2	366.9	341.4	322.2	302.0
1	0	0	0	557.3	503.8	465.3	427.4	387.3	361.1	340.5	319.9
1	0	0	1	592.5	537.4	497.1	458.0	415.9	388.1	366.8	344.8
1	0	1	0	622.5	565.9	524.8	484.3	441.4	412.1	389.7	366.7
1	0	1	1	653.3	595.8	553.3	511.5	467.1	437.0	414.2	390.0
1	1	0	0	672.8	614.2	571.8	529.5	483.7	452.8	429.2	405.0
1	1	0	1	700.5	641.7	598.2	554.8	507.9	476.3	451.8	426.6
1	1	1	0	725.3	665.8	621.5	577.3	529.4	497.5	472.1	446.0
1	1	1	1	750.0	690.0	645.0	600.8	552.0	519.0	493.5	466.5

DIP Switch Ampere Settings ES750
Table 3-11

DS1 POSITIONS				DS2							
				123	123	123	123	123	123	123	123
1	2	3	4	000	001	010	011	100	101	110	111
0	0	0	0	267.9	234.7	212.2	191.0	169.6	155.6	145.5	135.0
0	0	0	1	345.8	304.6	276.3	249.7	222.3	204.7	191.6	178.1
0	0	1	0	410.4	363.2	330.4	299.2	267.6	246.7	231.1	215.5
0	0	1	1	476.0	423.1	386.5	350.8	314.6	290.8	272.7	254.6
0	1	0	0	516.8	461.0	421.7	383.5	344.7	318.9	299.7	280.1
0	1	0	1	574.8	514.4	471.9	431.1	388.0	359.8	338.5	316.7
0	1	1	0	623.2	559.6	514.8	471.1	425.6	395.1	372.1	348.4
0	1	1	1	673.6	607.5	559.7	513.2	464.7	432.4	408.2	382.6
1	0	0	0	705.9	638.1	589.4	541.4	490.6	457.4	431.3	405.2
1	0	0	1	750.5	680.7	629.7	580.1	526.9	491.6	464.6	436.8
1	0	1	0	788.5	716.7	664.7	613.5	559.0	522.0	493.6	464.4
1	0	1	1	827.5	754.6	700.9	647.9	591.6	553.6	524.6	494.0
1	1	0	0	852.2	778.0	724.3	670.6	612.7	573.5	543.7	513.0
1	1	0	1	887.3	812.8	757.8	702.7	643.3	603.4	572.3	540.4
1	1	1	0	918.7	843.3	787.3	731.2	670.6	630.2	598.0	565.0
1	1	1	1	950.0	874.0	817.0	761.0	699.2	657.4	625.1	590.9

DIP Switch Ampere Settings ES950
Table 3-12

DIP Switch Settings

2. **DIP Switch 3 (DS3)**

DS3-1 Set to **OPEN** position for voltage ramp mode.
Set to **CLOSED** position for current ramp mode.

DS3-2 Set to **OPEN** position for energy saving ON.
Set to **CLOSED** position for energy saving OFF.

The DS3 switch is factory set with: DS3-1 **OPEN**, DS3-2 **OPEN**

3. **Voltage Plugs**

The Easy-Start ES is shipped with two voltage plugs in a separate envelope packaged with the unit. The Easy-Start ES will not operate until the appropriate voltage plug is installed.

The plugs are stamped with voltage ratings according to Table 3-13; and upon initial inspection.

Notice - A voltage plug selected from Table 3-13, must be installed into the socket (J5) on the logic board prior to start-up. (See Figure 4-14.)

There is also a jumper on the logic board that must be in one of two positions. These positions are marked **LO HI**. (See Figure 4-14.) ***The jumper is factory installed in the "HI" position.***

This jumper can remain in the **HI** position except when operating at the lowest line voltage rating of the two models rated: 208/230/460 and 460/500/575 volts. The jumper is then moved to the **LO** position to accommodate the low voltage end of the voltage combination. Refer to Table 3-13 for jumper positions.

EASY-START ES RATING	LINE VOLTAGE	PLUG TYPE	JUMPER POSITION
380/415 VAC	380V	380	HI
	415V	415	HI
208/230/460 VAC	208V	230	LO
	230V	230	HI
	460V	460	HI
460/500/575 VAC	460V	500	LO
	500V	500	HI
	575V	575	HI

Voltage Plugs and Jumper Positions
Table 3-13

DIP Switch Settings

4. **Time** - The ramp time is adjustable from 1 to 40 seconds. The maximum setting is at the full clockwise position. In the voltage-ramp mode, this function ramps the motor voltage up from an initial step to full line voltage. The motor may come up to speed before the voltage ramp is finished; this depends on the application and the type of load on the motor. The voltage ramp will continue until full motor voltage is reached. This is called **END OF RAMP**. (Factory setting of "Time" is approximately 20 secs.)

   If the energy-saving switch is in the **OPEN** position, and if the motor is not fully loaded, the motor voltage will then be reduced, while still maintaining the motor rated slip speed. The starter will now be running in the "Energy-Saving" mode.

   If the energy-saving switch is in the **CLOSED** position, the motor voltage will remain at full voltage and will be essentially running across line.

   In the current-ramp mode, this function ramps the motor current up from an initial step to a point where the current limit is set, or to the point where break-away torque occurs. The motor may come up to speed in a shorter time period than the ramp "Time" setting. This depends on the type of load on the motor. Whenever the motor comes up to rated speed, the current will decrease from a starting current to a running current. The current ramp will automatically terminate and the motor will either run in the energy-saving mode or, across-line, depending on the position of the energy-saving switch.

5. **Initial Step** - This adjustment sets the initial voltage which is applied to the motor when the start command is given. The maximum setting is at the full clockwise position.

   This adjustment should be set in conjunction with the "Time" adjustment. With the "Time" adjustment set to mid-range, and the "Initial Step" set to minimum (CCW), start the motor and check its response in your particular application. If a higher initial voltage is needed to start the motor turning quicker, increase the "Initial Step."

   It may require several adjustments and several motor starts in order to optimize the "Time" and "Initial Step" settings. A combination of these adjustments is what gives us a "Soft-Start."

   The "Initial Step" is factory set as follows: Approximately 50% on initial voltage and 150% on initial current.

6. **Current Limit** - The current limit is adjustable from 200 to 500% of the DIP switch current setting.

   The maximum setting is at the full clockwise position. It can over-ride both initial step and ramp time in the start mode.

   This adjustment can control the available starting torque.

   It is also used to limit the inrush current on the power lines, or generator, feeding the starter.

   It is also used to limit the locked rotor current, in case of a stalled motor condition on start-up.

   The current limit adjustment should always be set high enough to insure starting of the motor under the worst case load conditions.

Notice - The **Cur Lim** is factory set to 450%.

DIP Switch Settings

7. **Current Trip** - The current trip is adjustable from 100 to 120% of the DIP switch current setting.

   It is active all the time; during start and run. The maximum setting is at the full clockwise position.

   This adjustment is used to accommodate the service factor rating of the motor. For example, for a service factor of 115%, the control should be set to 3/4 clockwise.

   The current trip adjustment will affect the entire overload trip-time curve. (See Figure 3-1.)

Notice - The **Cur Trip** is factory set to approximately 100%.

8. The following adjustments are done at the factory:

   A. **MIN** volts
   B. **MAX** volts
   C. **STAB**

   A. **Minimum volts** is set to 50% of line voltage. This adjustment should only be made with DS3-2 **OPEN**.

      Example: The motor volts is set to 240 volts when running from a 480V power line. This is done at the factory with the motor running at no load.

      It is important to note that the voltage applied to the motor by the Easy-Start ES is entirely dependent on the motor load. For example, take the extreme case when the motor is running at 100% of rated load; the motor voltage should not be reduced since it could cause the motor to overheat due to excessive current.

      The Easy-Start ES automatically adjusts the motor voltage to the value necessary to maintain normal operation at the most efficient energy usage. If the motor voltage is not as low as it was expected to be, it is most likely that the motor is not fully unloaded.

      Notice - The factory setting of 50% should be satisfactory for the majority of applications.

   B. The maximum volts is set at the factory for 100% motor voltage at 100% motor load.

      Notice - This factory setting does not normally require readjustment.

      The **MIN VOLTS** adjustment must be made first, before attempting to adjust the **MAX VOLTS**.

      Here is a procedure that can be followed if it becomes necessary to adjust the max volts:

      This adjustment should only be made with DS3-2 **OPEN**. Connect a voltmeter to the line side and another voltmeter to the load side of the starter. Use an ammeter to monitor the motor current. Increase the motor load to 100% of rating by observing when the motor current reaches its FLA rating; adjust the **MAX VOLTS** until the motor voltage is nearly equal to the line voltage. There will be approximately a one or two volt loss in the power semiconductors.

      Notice - Maximum volts adjustment is to optimize energy savings and will not protect starter against abnormally high line voltages.

DIP Switch Settings

The **MIN VOLTS** and **MAX VOLTS** adjustments enable the Easy-Start ES to automatically follow the motor load and adjust the motor voltage to the value necessary to maintain normal operation at the most efficient energy usage.

C. **Stability Adjust** - Every system has its own unique inertial response. It is the job of the Easy-Start ES starter control circuit to regulate over a very broad range of systems. Failure of a controller to regulate can result in very large current surges while the load is constant.

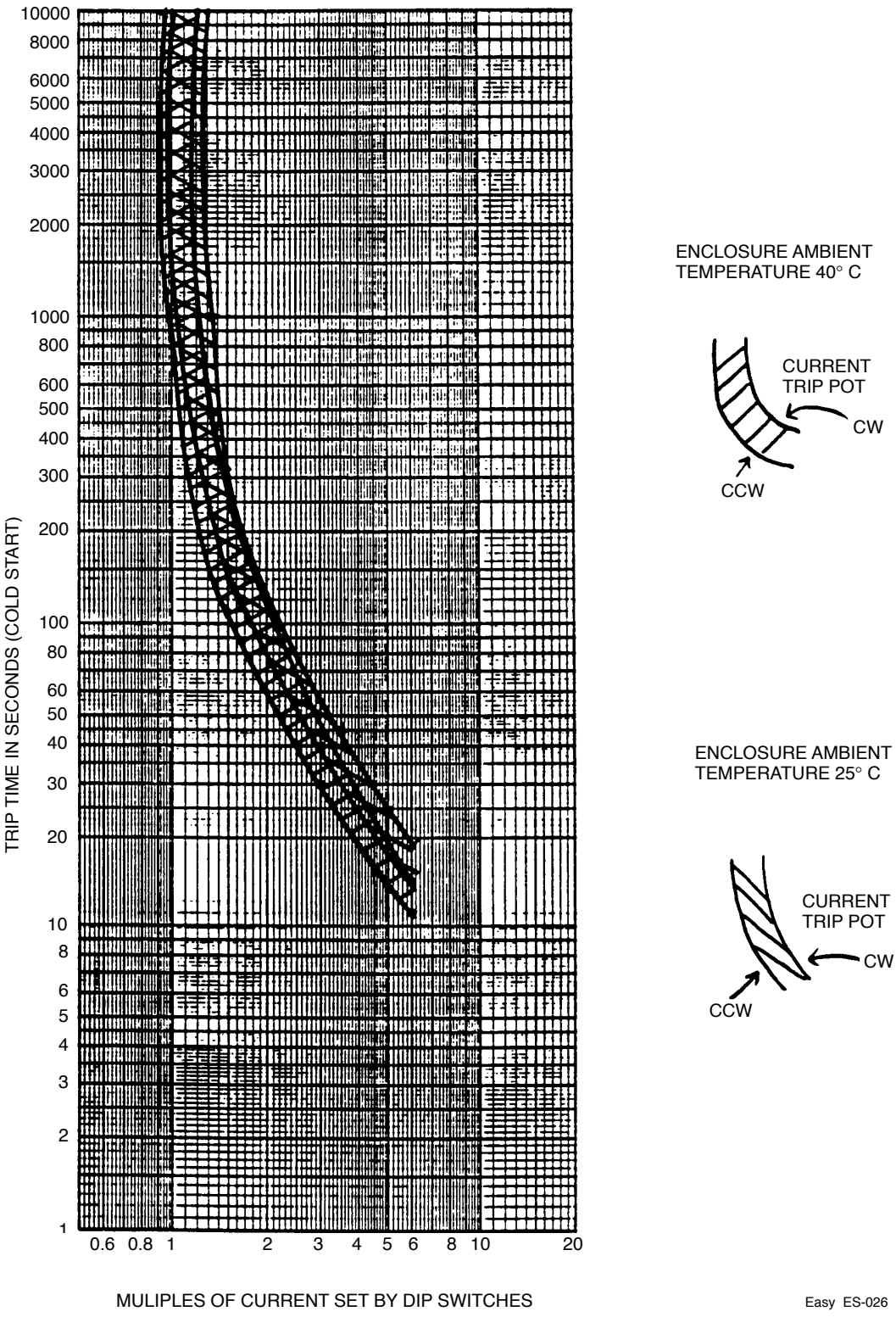
The Easy-Start ES control performs this job very well for nearly every application. There are, however, a few stubborn cases. For these special cases a stability adjustment **STAB** has been included to compensate the control to match the system response.

PROCEDURE: Connect a voltmeter between any two phases at the load terminals. If the voltage remains constant, or, if it varies proportional to load changes, the starter is regulating and no adjustment is required.

If the load is constant but the voltage changes erratically, adjust **STAB** until the voltage is steady.

⚠ Caution

Caution should be taken to determine whether the voltage is changing because of instability or load changes. If there is a doubt, the system is most likely operating properly. If it is unstable there is usually very little doubt, as the changes will produce very violent surging.



Over-Load Time-Current Characteristics
Figure 3-1

SECTION 4
Options

About This Section

This section of your Easy-Start ES Instruction Manual identifies options which are available factory installed for enclosed models only. After reviewing this section you will understand:

- Easy Start ES options that are available.
- Application notes for available options.

Options

SECTION 4

Available Options

All Easy-Start ES options are available as ***factory installed for enclosed models*** only and must be ordered with Easy-Start ES. By checking the nameplate or by visual inspection it can be determined what options are supplied with a unit.

Operator Devices: Following is a list of available options.

Cat. No. Suffix	Description
A	Start (Green), Stop (Red), Reset (Gray) pushbuttons.
B	Hand-Off-Auto Selector Switch (Gray), Reset (Gray) pushbutton.
A2	Start (Green), Stop (Red), Reset (Gray) pushbuttons and Hand-Off-Auto Selector Switch (Gray). In Hand position the unit is controlled by start stop pushbuttons and in Auto position it is controlled by a remote maintained contact input.
F2	Ammeter 1-Phase.
F3	Ammeter 3-Phase with Switch.
G2	Voltmeter 1-Phase.
G3	Voltmeter 3-Phase with Switch.
H	Elapsed Time Meter.
L5	Power **ON** - Red push-to-test pilot light.
L6	**RUN** - Green push-to-test pilot light.
L4	**TRIP** - Amber push-to-test pilot light.
R	**RESET** - Pushbutton (Gray)

Control Devices:

Cat. No. Suffix	Description
Y	Auxiliary run relay 2 N.O. 2 N.C. contacts, unwired. Coil rating 110/120 VAC Contact Rating 10 Amps AC

Hevi-Duty Company Transformer Connections

T	150VA control power transformer with 2 primary fuses.

Easy-Start ES models have multi-voltage ratings. Each model is factory wired for the following incoming line voltage for Hevi-Duty Company transformer:

Easy-Start ES Voltage Rating	CPT Wired For
208/230/460	460V
380/415	380V
460/500/575	575V

If the incoming line voltage is different than the one shown in above table, reconnect the CPT primary and secondary as follows:

Line Voltage	Primary FU-2 Connection	Secondary Connection	Secondary Voltage
208 VAC	H2	X4	110 VAC
230 VAC	H2	X3	115 VAC
380 VAC	H3	X4	120 VAC
415 VAC	H3	X3	120 VAC
460 VAC	H4	X3	115 VAC
500 VAC	H5	X4	110 VAC
575 VAC	H5	X3	115 VAC

The primary to FU-3 is factory connected to H1. One secondary lead is factory connected to X1. The X1 and H1 connections remain the same for all line voltages.

Available Options

Cat. No. Suffix	Description
T2	300VA control power transformer. Other details
T4	500VA control transformer. Other details same as T.
Y2	Time delay relay, (type TR) delay on make. **Programmable Time Settings:** 1, 3, 6, 10, 60 seconds 5, 10 minutes
Y3	Auxiliary relay, contacts and coil unwired.

Control Devices:

Cutler-Hammer Transformer Connections

Cat. No. Suffix	Description
T	150VA control power transformer with 2 primary fuses.

Easy-Start ES models have multi-voltage ratings. Each model is factory wired for the following incoming line voltage for Cutler-Hammer transformer:

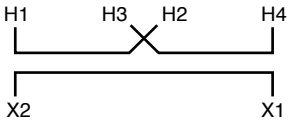
Easy-Start ES Voltage Rating	CPT Wired For
208/230/460	460V
380/415	380V

If the incoming line voltage is different than the one shown in above table, reconnect the CPT primary and secondary as follows for Cutler-Hammer transformers:

Line Voltage	Primary FU-4 Connection	Secondary Connection	Jumper	Secondary Voltage
208 VAC	H5	X3	H1 to H3 and H2 to H5	110 VAC
380 VAC	H4	X3	H2 to H3	120 VAC
415 VAC	H5	X3	H2 to H3	120 VAC
460 VAC	H4	X2	H2 to H3	115 VAC
230 VAC	H4	X2	H1 to H3 & H2 to H4	115 VAC

The primary to FU-3 is factory connected to H1.
One secondary lead is factory connected to X1.
The X1 and H1 connections remain the same for all line voltages.

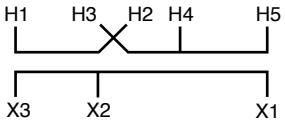
Diagram 1



Volts	Connect	Lines
460	H2 to H3	H1-H4
230	H1 to H3 & H2 to H4	H1-H4
115		X1-X2

Easy ES-052

Diagram 2



Volts		Connect	Lines
	B		
416		H2 to H3	H1-H5
380		H2 to H3	H1-H4
		H1 to H3 & H2 to H4	H1-H4
208		H1 to H3 & H2 to H5	H1-H5
115			X1-X3
95			X1-X2

Easy ES-053

Available Options

Available Plug-In Option Kits

Description	Catalog Number
Extended Start Time	KITESE

Notice - May require oversized Easy-Start ES and may require changing thermal magnetic molded case circuit breaker (if optionally ordered) to magnetic trip only.

Extended Start Time With Light	KITESE1
Smooth Stop	KITESS
Smooth Stop With Light	KITESS1
Smooth Stop With Two Lights (Smooth Stop & Ramp-up)	KITESS2
Jam and/or Underload	KITESJ
Jam and/or Underload With Jam Light	KITESJ1
Jam and/or Underload With Underload Light	KITESJ2
Daughter Board Assembly	KITESD

Circuit Breakers

The circuit breakers offered with Easy-Start ES are listed in Tables 4-1 and 4-2. The interrupting rating and terminal sizes are listed in Table 4-3.

⚠ Caution

The nominal HP is listed for reference only. The circuit breaker should be selected based on motor full load and locked rotor KVA Code and meet all requirements of National Electrical Code.

The adjustable trip circuit breakers should be set at time of installation for the specific motor in accordance with above. For most applications the following guidelines should be sufficient.

- Thermal trip should not exceed 2.5 times the motor FLA.
- Magnetic trip should not exceed thirteen times the motor FLA.
- Breaker trip time should be greater than 20 seconds at 5 times the motor FLA.

Available Options

Circuit Breakers

Option No. Thermal Magnetic	With Shunt Trip	Easy-Start ES Model	Frame Size	Breaker Type	Amps	Mag. Trip Adj.	Nominal HP	
							208 230V	460 575V
C01	C30	ES045(1)	F	HFD	30	(1)---	5	15
C02	C31	ES045(1)	F	HFD	60	(1)---	15	30
C03	C32	ES070(1)	F	HFD	100	(1)---	20	40
C22	C51	ES070(1)	F	HFD	150	(1)---	25	50
C04	C33	ES120	J	HJD	150	5X-10X	25	50
C05	C34	ES120	J	HJD	200	5X-10X	40	75
C06	C35	ES120	J	HJD	250	5X-10X	50	100
C07	C36	ES180(2)	K	HKD	200	5X-10X	40	75
C08	C37	ES180(2)	K	HKD	250	5X-10X	50	100
C09	C38	ES180(2)	K	HKD	300	5X-10X	75	150
C10	C39	ES250(2)	K	HKD	400	5X-10X	100	200
C10	C39	ES260(2)	K	HKD	400	5X-10X	100	200
C11	C40	ES360	MC	HMC	800 (3)	3X-10X (5)	150	300
C11	C40	ES500	MC	HMC	800 (3)	3X-10X (5)	200	450
C11	C40	ES560	MC	HMC	800 (3)	3X-10X (5)	200	450
C12	C41	ES750	NC	HNC	1200 (4)	2X-8X (5)	300	600
C13	C42	ES950	NC	HNC	1200 (4)	2X-8X (5)	400	800

Thermal-Magnetic Breaker
Table 4-1

(1) All ratings shown above for HFD type can be used with either ES045 or ES070 models. Magnetic trip adjust is not available on HFD type. Magnetic trip is set at approximately 10 times the circuit breaker trip rating.

(2) All ratings shown above for HKD type can be used with either ES180, 250 or ES260 models.

(3) Adjustable rating plug 400-800 Amps.

(4) Adjustable rating plug 600-1200 Amps.

(5) When adjustable rating plugs are used, short delay pickup (magnetic) settings track the selected position of the adjustable rating plug. For example, with an adjustable 800 amp rating plug set at 50%, and the short delay pickup (magnetic) set at 4X, the short delay pickup is 800 x 50% x 4=1600 amps.

Available Options

Circuit Breakers

Option No. Thermal Magnetic	With Shunt Trip	Easy-Start ES Model	Frame Size	Breaker Type	Amps	Mag. Trip Adj.	Nominal HP	
							208 230V	460 575V
C14	C43	ES045(1)	F	HMCP	30	3X-10X	5	15
C15	C44	ES070(1)	F	HMCP	100	3X-10X	25	50
C16	C45	ES120	J	HMCP	250	3X-6X	50	100
C17	C46	ES180(2)	K	HMCP	400	2.5X-5X	75	150
C18	C47	ES250(2)	K	HMCP	400	3.75X-7.5X	100	200
C18	C47	ES260(2)	K	HMCP	400	3.75X-7.5X	100	200
C19	C48	ES360	MC	HMC	800	3X-10X	150	300
C19	C48	ES500	MC	HMC	800	3X-10X	200	450
C19	C48	ES560	MC	HMC	800	3X-10X	200	450
C20	C49	ES750	NC	HNC	1200	2X-8X	300	600
C21	C50	ES950	NC	HNC	1200	2X-8X	400	800

Magnetic Breaker
Table 4-2

(1) Both ratings shown above for “F” frame size can be used with either ES045 or ES070 models.

(2) Both ratings shown above for “K” frame size can be used with either ES180, 250 or ES260 models.

Available Options

Circuit Breakers

Circuit Breaker Type	Max Breaker Amps	UL489 Interrupting Capacity Rating			Wire Range Terminals
		240V	480V	600V	
HFD	100	100,000	65,000	25,000	#14 -1/0
HFD	150	100,000	65,000	25,000	#4 - 4/0
HJD	250	100,000	65,000	25,000	#4 - 350 MCM
HKD	200	100,000	65,000	25,000	#3 - 350 MCM
HKD	250	100,000	65,000	35,000	250-500 MCM
HKD	300	100,000	65,000	35,000	250-500 MCM
HKD	400	100,000	65,000	35,000	3/0-250 MCM (2)
HMC	800	65,000	50,000	25,000	500-750 MCM (2)
HNC	1200	65,000	50,000	25,000	4/0 - 500 MCM (4)

Circuit Breaker Interrupting Rating and Terminal Sizes
Table 4-3

Available Options

Special Functions

Cutler-Hammer “IQ Data Plus II” Monitoring Device, catalog suffix “Q8”, provides the following readings:

AC Ampere Phase A
Phase B
Phase C

AC Voltage
Phase A-B Phase A-Neutral
Phase B-C Phase B-Neutral
Phase C-A Phase C-Neutral

Megawatts
Megavars
Power Factor
Frequency
Megawatt Demand

The IQ Data Plus II is offered as a monitoring device only and all protective functions are disabled, or set so they do not race with Easy-Start ES protective functions.

The following CT’s are supplied with the IQ Data Plus:

Easy-Start ES Cat. No.	CT
ES045, ES070	Three 100:5 CT’s
ES120	Three 200:5 CT’s
ES180, ES250, ES260	Three 300:5 CT’s
ES360	Three 500:5 CT’s
ES500, ES560	Three 800:5 CT’s
ES750, ES950	Three 1000:5 CT’s

Notice - IQ Data Plus II Ampere Display Range:
Minimum: 2% of CT used with IQ
Maximum: 500% of Easy-Start ES Maximum Ampere Rating

If local codes or customer preference prohibit line voltage on the door, do not use this option.

Cutler-Hammer “IQ Data” Monitoring Device, catalog suffix “Q7”, provides the following readings:

AC Ampere Phase A
Phase B
Phase C

AC Voltage (Motor)
Phase A-B
Phase B-C
Phase C-A

The following CT’s are supplied with the IQ Data:

Easy-Start ES Cat. No.	CT
ES045, ES070	Three 100:5 CT’s
ES120	Three 200:5 CT’s
ES180, ES250, ES260, ES360	Three 300:5 CT’s
ES500, ES560	Three 800:5 CT’s
ES750, ES950	Three 1000:5 CT’s

Notice - IQ Data Ampere Display Range:
Minimum: 2% of CT used with IQ
Maximum: 500% of Easy-Start ES Maximum Ampere Rating

If local codes or customer preference prohibit line voltage on the door, do not use this option.

Available Options

Special Function (Option Boards)

Special function option boards E, S and J plug into main logic board.

Catalog Suffix:

OPTION	DESCRIPTION
"E"	Extended start time
"S"	Smooth-Stop
"J"	Jam-Underload

Extended Start Time:

Option "E"

The printed circuit board contains three functions:

1. Extended Start Time (adjustable 0.5 to 10.5 minutes).
2. End of Ramp-Up Relay (Form-C contacts, rating: 1 amp 120V ac).
3. Extended Time-Current (end of ramp-up D.C. signal voltage).

These functions may be used together or independently. The board is factory set with all functions de-activated. DIP switch DS22, with its 2-positions, is used to activate the extended start time and the end of ramp-up relay functions.

Extended Start Time		Function
DS22-1	**Open "0"**	**OFF**
	Closed "1"	**ON**

End of Ramp-Up Relay		Function
DS22-2	**Open "0"**	**OFF**
	Closed "1"	**ON**

The third function, Extended Time-Current, is activated by connecting a wire between the option board (TB22-1) and the main logic board (TB1-8). This connection activates DS2 on the logic board at the end of ramp-up.

The Extended Time-Current feature is accomplished by calibrating the starting current with main DIP switch DS1, and after the motor has accelerated to full speed, (end of ramp-up) by calibrating the Easy-Start ES for the normal running current, based on the settings of both DS1 and DS2.

Option "E1"

This option includes the printed circuit board with its three functions plus a ramp-up red light. (See this section for option "E" and "E1" application considerations.)

Special Function:

Smooth Stop

Option "S"

The printed circuit board contains three functions:

1. Smooth-Stop (adjustable 1 to 30 seconds with potentiometer SS time).
2. End of Ramp-Up Relay (Form-C contacts, rating: 1 amp 120V ac).
3. Extended Time-Current (end of ramp-up D.C. signal voltage).

These functions may be used together or independently. The board is factory set with all functions de-activated. DIP switch DS31, with its 2-positions, is used to activate the smooth-stop and/or end of ramp-up relay functions.

Smooth-Stop		Function
DS31-1	Open "0"	OFF
	Closed "1"	ON

End of Ramp-Up Relay		Function
DS31-2	Open "0"	OFF
	Closed "1"	ON

Available Options

Special Function

The third function, Extended Time-Current, is activated by connecting a wire between the option board (TB37-1) and the main logic board (TB1-8). This connection activates DS2 on the logic board at the end of ramp-up.

The Extended Time-Current feature is accomplished by calibrating the starting current with main DIP switch DS1, and after the motor has accelerated to full speed, (end of ramp-up) by calibrating the Easy-Start ES for the normal running current, based on the settings of both DS1 and DS2.

Option "S1"

This option includes the printed circuit board with its three functions plus a red light that lights when the smooth-stop is activated, and goes out whenever the smooth-stop is completed.

Option "S2"

This option includes the printed circuit board with its three functions plus a red light that lights when the smooth-stop is activated, and goes out whenever the smooth-stop is completed; plus a red light that lights during ramp-up and goes out at the end of ramp-up. (See this section for option "S", "S1", and "S2" application considerations.)

Special Functions: Option "J"

The printed circuit board contains two functions: **JAM** and **UNDERLOAD TRIP**

There are four DIP switches mounted on the Option J Board:

DS40: (4-Position switch; 16 calibration points) sets JAM trip level.
Adjustable 100-250%; as set by DS1 & DS2 DIP switch calibration settings on main logic board.

DS41: (3-Position switch)
1. Turns JAM trip function **ON** or **OFF**; closed **ON**, open **OFF**.
2. Adjusts the JAM trip time; close to increase JAM trip time.
3. Adjusts the JAM trip time; close to increase JAM trip time.
(See this section for JAM trip time curves.)

DS42: (4-Position switch; 16 calibration points) sets underload trip level. Adjustable 25-90%; as set by DS1 & DS2 DIP switch calibration settings on main logic board.

DS43: (3-Position switch)
1. Turns the underload function on or off; closed **ON**, open **OFF**.
2. Adjusts the underload trip time; close to increase trip time.
3. Adjusts the underload trip time; close to increase trip time.
(See this section for underload trip time curves.)

Available Options

Special Functions: Option "J"

The board is factory set with both functions de-activated. The table below gives instructions on how to activate the two functions:

Jam Trip		Function
DS411	**Open "0"**	**OFF**
	Closed "1"	**ON**

Underload Trip		Function
DS431	**Open "0"**	**OFF**
	Closed "1"	**ON**

JAM: Extra Form-C contacts, rated 1 amp, 120V ac available at TB41.
UNDERLOAD: Extra Form-C contacts, rated 1 amp, 120V ac available at TB43.

Option "J1"

This option includes the printed circuit board, plus a door mounted "JAM TRIP" red light.

Option "J2"

This option includes the printed circuit board, plus a door mounted "UNDERLOAD TRIP" red light.

Options: Shorted SCR Detector (Hard Mounted, ***not a plug-in board***)

Option "U"

The shorted SCR detector will operate on line voltages from 208V to 575V ac.

There are 5 LED indicators on the Printed Circuit Board:

POWER ON	GREEN	"120 Volts AC is applied to the board."
SHORTED SCR	RED	
PHASE A	GREEN	
PHASE B	GREEN	
PHASE C	GREEN	

In order for the three LED indicators PHASE A, B, and C to operate, three phase line power must be applied to the Line Terminals of the Easy-Start ES. The three indicators PHASE A, B, and C will be on, whenever the SCRs are not fully on, or not shorted. The LED indicators will be off whenever the SCRs are fully on, or when shorted. During normal operation of the starter, if full voltage is applied to the motor, the three LEDs, PHASE A, B, and C will be off.

If an SCR in one phase is shorted, that phase indicator will remain off, while the other two indicators will remain on. If an SCR shorts, a signal is sent to the Easy-Start ES main logic board, which trips the Starter off line, and a red LED is illuminated on the shorted SCR Detector Board.

Option "U1"

This option includes the Printed Circuit Board as described above, plus a door mounted **SHORTED SCR** red light.

Available Options

Daughter Board

Option "D"

The Option Daughter Board is used whenever two or more Special Option Boards are supplied with the Easy-Start ES.

These option boards must be the plug-in type. The Daughter Board will accommodate any two of the following boards:

- E Option - Extended Start Time
- S Option - Smooth-Stop
- J Option - Jam/Underload

Whenever there are two or more plug-in option boards needed, one of the boards is plugged into the Mother Board (Main Logic board). The second and third boards, if necessary, are plugged into the Daughter Board.

The Daughter Board contains a 12 volt D.C. power supply. This power is used to supply the extra D.C. current needed for the additional option boards. The Daughter board is connected to 120 VAC on the Main Logic Board.

See Figure 4-13, for connection diagram.

Notice - A ribbon cable must be installed between the option board, which is plugged into the main logic board, and the daughter board.

Application Notes

Extended Start Time Option

This option is used to extend the starting time. It inhibits the Inverse Time Trip function output, on the Easy-Start ES Logic Board during this time period. The total time, for which the Inverse Time Trip function is inhibited, is adjustable from 2 to 12 minutes in discrete intervals, by using a DIP switch on the option board. All other protective features, such as Instantaneous Overcurrent Trip, Under-Voltage Trip, Phase Loss, are still able to function.

The Easy-Start ES must be sized to handle the expected starting current for up to 12 minutes. Use the rating curves (Figures 4-1 and 4-2) in the Instruction Manual in order to determine the Current rating vs Time.

During the extended start time period, there is no motor overload protection provided by the Easy-Start ES. The user should also consult with the motor manufacturer and make sure that the motor can handle the long starting duty at the prescribed current set by the Easy-Start ES. The current limit is in effect during this extended starting time and is adjustable from 200 to 500% of the DIP switch setting.

The Inverse-Time Current Trip Circuit is accumulating the Current Signals at all times, and has a built-in thermal memory on "cool-down." This cool-down period of time can be as long as 1.5 minutes. Therefore, it is necessary to set the extended start time for 1.5 minutes longer than the anticipated starting time of the motor. This permits the Inverse-Time Current Trip Circuit to be cooled down after start, so that when the Inverse-Time Trip is re-activated, nuisance trips will be avoided.

Example: If the motor starting time is anticipated to be 5 minutes with the selected current limit setting, the extended time on the option board should be set to 6.5 minutes.

Notice - At the end of 6.5 minutes, if the motor has not started, and is still in current limit, the Easy-Start ES will immediately shut off and indicate a "Current Trip" condition.

DIP switch DS22 is a 2-position switch located on the option board. It is used to turn the options on or off, since there may be more than one option on a single board.

The **EXTENDED START TIME** function can be turned on and off with the first position on this switch, DS22-1 (**OPEN**=off, **CLOSED**=on). DS22-1 is factory set to the **OFF** position.

DIP switch DS21 is a 4-position switch and can be used to set the total **EXTENDED START TIME** in discrete steps.

Application Notes

The table below shows the DIP SW DS21 settings along with the user determined start time, cool down time, and the total time in minutes:

DIP Switch DS21 Code

"1" = Closed
"0" = Open

DS21 1234	USER DETERMINED START TIME	COOL DOWN TIME	TOTAL TIME MINUTES
1111	0.5	1.5	2.0
0111	0.6	1.5	2.1
1011	0.7	1.5	2.2
0011	0.8	1.5	2.3
1101	1.0	1.5	2.5
0101	1.2	1.5	2.7
1001	1.4	1.5	2.9
0001	1.5	1.5	3.0
1110	2.5	1.5	4.0
0110	2.8	1.5	4.3
1010	3.6	1.5	5.1
0010	4.2	1.5	5.7
1100	5.0	1.5	6.5
0100	6.0	1.5	7.5
1000	8.5	1.5	10.0
0000	10.5	1.5	12.0

Easy-Start ES End-of-Ramp Option

This option is supplied on the same PC board as the Extended Start Time Option. It senses the SCR trigger analog voltage and sends out a signal to tell us whenever the End of Ramp is reached. This signal indicates that the motor has reached 100% voltage and the SCRs are **FULL ON**. This output signal is sent to a relay with 2 Form-C contacts (rated 1 amp 120V ac) which change state at the **END-OF-RAMP**. These 2 Form-C contacts are brought out to 2 terminal blocks on the Option Board; (TB21 and TB23).

Some typical applications for this option are:

- By-Pass Contactor control signal. (Figure 4-3.)
- Sequential Starting of other motors, or process functions.

This **END-OF-RAMP** option will operate with the Easy-Start ES in either the Voltage Ramp or Current Ramp mode. However, it will only send out a signal whenever the motor voltage reaches 100%. Therefore, when running in the Current Ramp mode, there may be a time lapse before the **END-OF-RAMP** signal is executed. The reason being that the current will usually reach the end of its ramp-up before the motor reaches full voltage. This depends on the type of load-torque and inertia being impressed on the motor.

The **END-OF-RAMP** option can be turned on and off with DIP switch DS22-2 (**OPEN**=off, **CLOSED**=on) located on the option board.

DS22-2 is factory set to the off position.

Extended Time-Current Option

This option enables the Easy-Start ES to extend the time and current during Motor Starting. It is supplied on the same PC board as the Extended Start Time option.

This feature is helpful when a customer wishes to start a motor under a current limit which is beyond the normal current limit range of 200% to 500% of the Easy-Start ES DIP switch setting, but when the customer still wishes to have accurate overcurrent protection during normal "run" conditions.

By using an ***oversized*** Easy-Start ES model, starting currents of 600% and greater can be obtained, and still maintain motor protection during starting and running.

Application Notes

Extended Time-Current Option

This option would enable the Easy-Start ES to be used on NEMA A, B, C, D, or any three-phase induction motor with locked rotor codes up to 8.0 KVA per horsepower.

This **EXTENDED TIME-CURRENT** feature is accomplished by calibrating the starting current with main DIP switch DS1, and after the motor has accelerated to full speed, by re-calibrating the Easy-Start ES for the normal running current, based on the settings of both DS1 and DS2. (See Example-1.)

Terminal TB1-8 on the main logic board is the enable terminal for DS2. It can be enabled with a +12V dc signal.

The Extended Time-Current option cannot be turned on and off with a DIP switch. In order to enable this option, ***a connection must be made between TB22-1 on the option board and TB1-8 on the main logic board.*** The option board then applies +12V dc to TB1-8 on the logic board at the End-Of-Ramp, and electrically switches the ac current calibration from **STARTING** current to **RUNNING** current.

Notice - When using the **Extended Time-Current** option, do not make a connection between TB1-2 and TB1-8 on the main logic board.

Example-1:

Motor: 150 HP, 180 Amps, 460V ac 3-phase,
service factor=1.00
Locked rotor code-**G**
(5.6 - 6.29 KVA per HP)

Max Locked Rotor Current
= 6.29 KVA/HP X HP /460 X 1.732
= 6.29 X 1000 X 150/460 X 1.732
= 1184 AMPS (658% FLA)

To determine which Easy-Start ES rating will be needed:
Divide 1184 by 5 1184/5 = 236.8 Amps

Use a model rated equal or greater than 236.8 amps.
Select Model ES260: Rated at 260 amps continuous
Rated at 5 X 260
= 1300 amps 20 seconds, which is more than the 1184 amps required.

Application Notes

Example-1 Continued:

How to Select Settings for DIP Switches DS1 and DS2 on Logic Board:

(Refer to Instruction Manual, Table 3-1). Select DS1 by looking in first column (DS2=000). Use a rating that is equal or slightly higher than 236.8 amps. Since we must satisfy both starting and running current, we must look at the same row, reading across, to find a setting equal or slightly less than the FLA (180 amps). We select 242.8 from the 1st column and 176.1 in the same row, reading across to the right.

DS1 Setting "1101" (Note: The 1st column must always be used for the Starting Current Calibration.)

242.8 Amps: "Starting" Current Calibration

- Current Limit Adjust (200-500%) 486-1214 amps.

- Set Current Limit full CW 1214 amps, which exceeds the Max Locked Rotor Current of 1184 amps. This is 658% of motor full load amps. At this ac current level, and with a current trip setting of 1.00, the trip time will be approximately 15 seconds.

  This setting of DS1 would permit starting under full locked rotor conditions because when utilizing the Extended Time-Current option, only DIP switch DS1 is in effect during start.

176.1 Amps: "Running" Current Calibration

- Current Trip Adjust (100-120%) 176-211 Amps.

- The normal factory setting is 100%. The Current Trip can be adjusted for other service factors if desired.

  The Extended Time-Current option automatically enables DIP switch DS2 at the End-Of-Ramp, and therefore the electronic overcurrent circuit would be calibrated to the combined settings of the two DIP switches DS1 and DS2.

DS1	DS2	Amps
1101	100	176.1

Application Notes

Example-2:

This is an application where a motor may require starting current of less than 500%, but for a longer period of time.

Below is a table showing trip time in seconds vs. percent current limit: points were taken from Figure 3-1 of the Instruction Manual. Data was taken from the 40°C ambient curves.

PERCENT CURRENT LIMIT						
	200%	250%	300%	350%	400%	500%
Curr Trip 1.00	60 Sec	40 Sec	30 Sec	24 Sec	20 Sec	14 Sec
Curr Trip 1.15	95 Sec	60 Sec	40 Sec	30 Sec	25 Sec	18 Sec
Curr Trip 1.20	100 Sec	70 Sec	45 Sec	35 Sec	27 Sec	20 Sec

Motor: 150 HP, 180 FLA, 460V ac 3-Phase, Service Factor = 1.00

Assume the starting requirement for the motor in this application is 350% current limit for 40 seconds.

3.5 X 180 = 630 Amps

If we select Easy-Start ES Model ES180 and set the DIP switch for the maximum of 180 amps, we conclude from the table above that the unit would trip in 24 seconds, at a curr trip setting of 1.00.

You must select an oversized starter; ***Select Model ES260***.

DS1 Setting “1111” (Note: The 1st column must always be used for the Starting Current Calibration.)

260.0 Amps: “Starting” Current Calibration

- Current Limit Adjust (200-500%) 520-1300 amps.

- Set Current Limit at 630 amps

  242% of Easy-Start ES rating, (about 1/6 CW) this is 350% of motor full load amps. At this ac current level, the trip time will be slightly greater than 40 seconds.

179.9 Amps: “Running” Current Calibration

- The Extended Time-Current option automatically enables DIP switch DS2 at the End-Of-Ramp, and therefore the electronic overload current circuit would be calibrated to the combined settings of the two DIP switches DS1 and DS2.

DS1	DS2	Amps
1111	101	179.9

Application Notes

Smooth-Stop Option

The Smooth-Stop option is available with the following variations:

Option "S" Printed circuit board with smooth-stop pushbutton and wired relay contact which opens the 120V ac control to the logic board at the end of the smooth stop.

Option "S1" Printed circuit board with smooth-stop pushbutton and red light that lights when the smooth-stop is activated and goes out whenever the smooth stop is completed.

Option "S2" Printed circuit board with smooth-stop pushbutton, smooth-stop red light, and a red light that lights during ramp-up and goes out at the end of ramp-up.

Check the product label on the Easy-Start ES to confirm which option package was supplied.

The smooth-stop printed circuit board contains the electronic logic for three different functions:

1. Smooth-Stop (1-30 seconds adjustable with potentiometer SS time)
2. End of Ramp-Up Relay
3. Extended Time-Current; (End of Ramp-Up DC Signal Voltage)

The input-output functions and relays are brought out to the seven terminal blocks on the printed circuit "S" option board:

(See Figure 4-16 for component layout.)

TB31-1, TB31-2 Input: Momentary N.O. pushbutton for smooth-stop.

TB32-1, TB32-2 1A contact, N.O., closes during smooth-stop.

TB33-1, TB33-2 N.C. contact, changes state at end of smooth-stop.

TB33-2, TB33-3 N.O. contact, changes state at end of smooth-stop.

TB34-1, TB34-2 N.C. contact, changes state at end of smooth-stop.

TB34-2, TB34-3 N.O. contact, changes state at end of smooth-stop.

TB35-1, TB35-2 N.C. contact, changes state at end of ramp-up.

TB35-2, TB35-3 N.O. contact, changes state at end of ramp-up.

TB36-1, TB36-2 N.C. contact, changes state at end of ramp-up.

TB36-2, TB36-3 N.O. contact, changes state at end of ramp-up.

TB37-1 output: +12V dc output at end of ramp-up.

TB37-2 Logic Ground

Both smooth-stop and end of ramp-up option functions can be turned on and off with one of two switches on the option "S" printed circuit board. These switches are identified as follows: DS31-1 and DS31-2.

Application Notes

Smooth-Stop		Function
DS31-1	Open “0”	OFF
	Closed “1”	ON

End of Ramp-Up Relay		
DS31-2	Open “0”	OFF
	Closed “1”	ON

The end of ramp-up relay can be used to control a by-pass contactor; see Figure 4-5. The interface relays K12 and K13 supply the proper 120V ac control logic to the by-pass contactor coil. Relay K12 activates at the end of ramp-up and relay K13 activates at the beginning of ramp-down (smooth-stop). When K13 opens, this opens K12 at the beginning of smooth-stop and this de-energizes the by-pass contactor coil.

The solid state starter is thus under control during the ramp-up (soft-start) and ramp-down (smooth-stop) portions of the motor control cycle.

The by-pass contactor is in control during the run mode (the period between the ramp-up and ramp-down). However, if a fault trip occurs, both the SCR’s and contactor are turned off, and motor protection is still maintained. The “RESET” button can be activated, once the fault is cleared, and the motor may be restarted.

Smooth-Stop Option When Used With “B” Option (HOA Switch)

1.0 Operating with HOA switch in “H” position.

1.1 Start motor by moving HOA switch from off to “H” position.

1.2 To stop motor using smooth-stop function, momentarily press the smooth-stop button, and then move the HOA switch to the “OFF” position.

Notice - The HOA switch must be moved to the “OFF” position after the smooth-stop button is pressed, or the motor will restart again after the smooth-stop is finished.

Smooth-stop is factory set to 30 seconds; adjustment can be made using potentiometer (SSTIME) on the smooth-stop board.

2.0 Operating with HOA switch in “A” position.

2.1 Start motor by closing contact across TB20-1 and TB20-2. (Located on back panel.)

2.2 To stop motor using smooth-stop function, momentarily press the smooth-stop button, and then open the remote contact across TB20-1 and TB20-2.

Application Notes

Smooth-Stop Option With Remote Maintained 2-Wire Contact

Figure 4-7 shows how a 2-wire remote contact is used to SOFT-START and SMOOTH-STOP the motor.

JAM Option

(Close DIP switch DS41-1 to activate the **JAM Trip** option.)

The JAM option is used to provide an immediate trip if there is an overload on the motor during the run mode. The JAM trip is de-activated during the **START** and **STOP** modes of the solid state motor starter operation.

If the motor current exceeds a preset value (set by DS40 on the J option board), the starter will trip.

The **JAM** overcurrent trip point is selectable between 100% and 250% of the Easy-Start ES main logic board current setting, by means of the 4-position DIP switch DS40; this switch is located on the **JAM** option printed circuit board.

(See Figure 4-8 below for DS40 settings and % trip points.)

Also, the inverse time delay of the **JAM** trip can be adjusted; DS41-2 and DS41-3 are used to adjust the trip time delay. The trip time delay works on an inverse-time-trip mode; ie. the greater the amount of overload, the faster the trip time. (See Figure 4-9 for trip time curves.)

Underload Option

(Close DIP switch DS43-1 to activate the "Underload" option.)

The Underload option is used to provide a trip when the motor goes from a loaded to an unloaded condition. The "Underload Trip" is de-activated during the "Start" and "Stop" modes of the solid state motor starter operation.

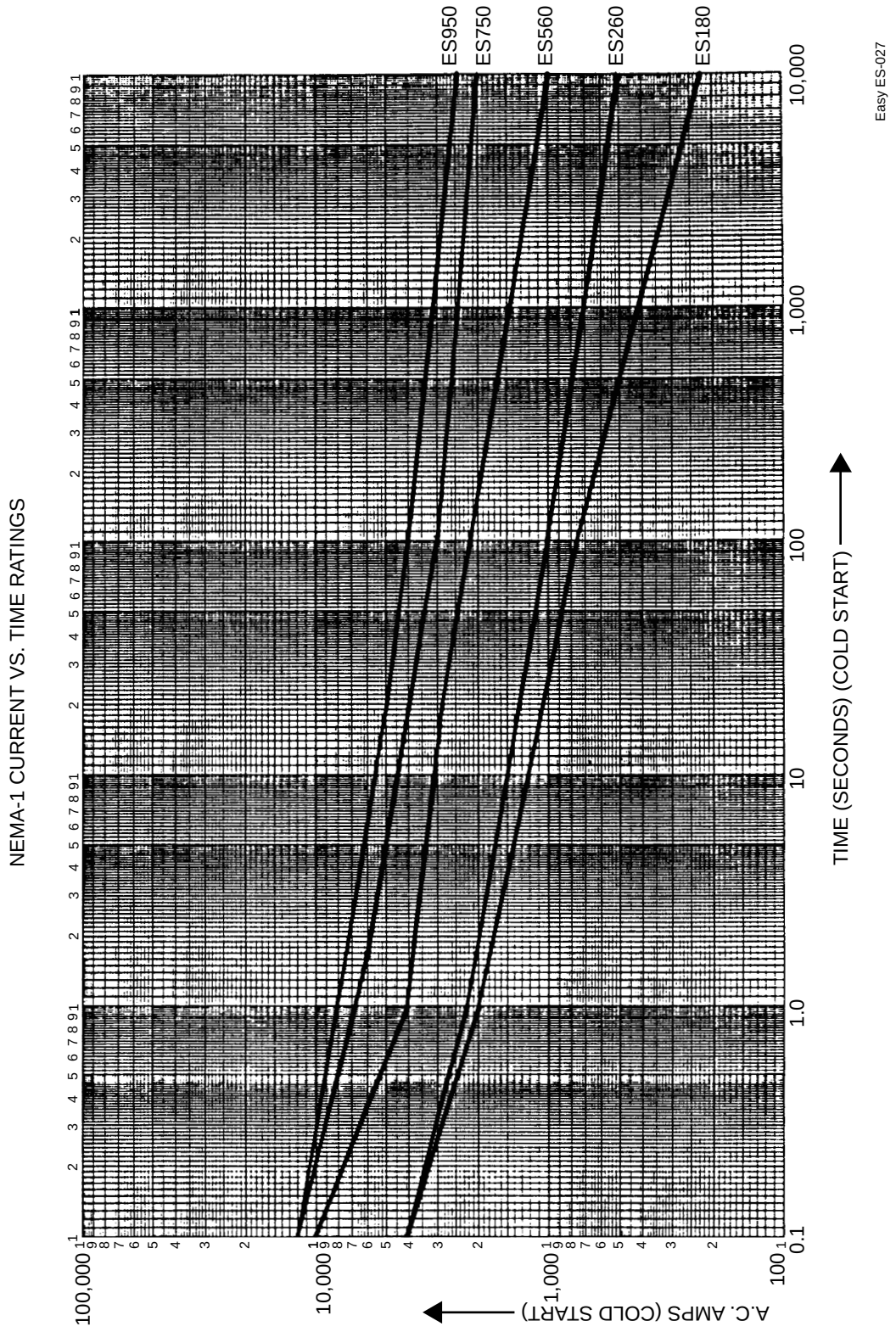
The underload trip point is adjustable between 25% and 90% of the Easy-Start ES main logic board current setting by means of the 4-position DIP switch DS42; this switch is located on the underload option printed circuit board. (See Figure 4-10 below for DS42 settings and % trip points.)

Also, the inverse time delay of the underload trip can be adjusted; DS43-2 and DS43-3 are used to adjust the trip time delay. The trip time delay works on an inverse-time-trip mode; ie the greater the amount of underload, the faster the trip time. (See Figure 4-11 for trip time curves.)

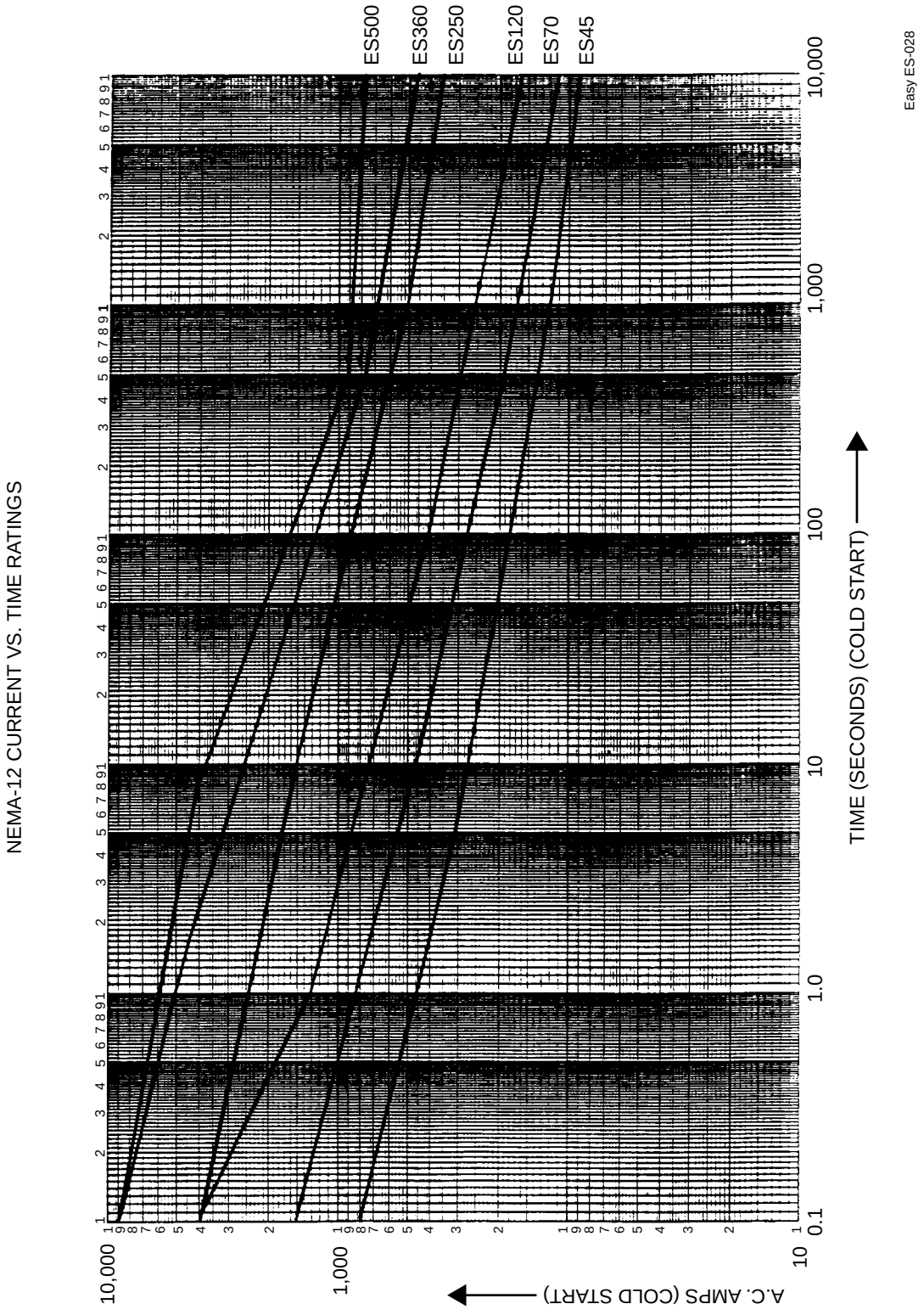
Drawings

This part of the *Options* section of this Instruction Manual presents the following series of drawings:

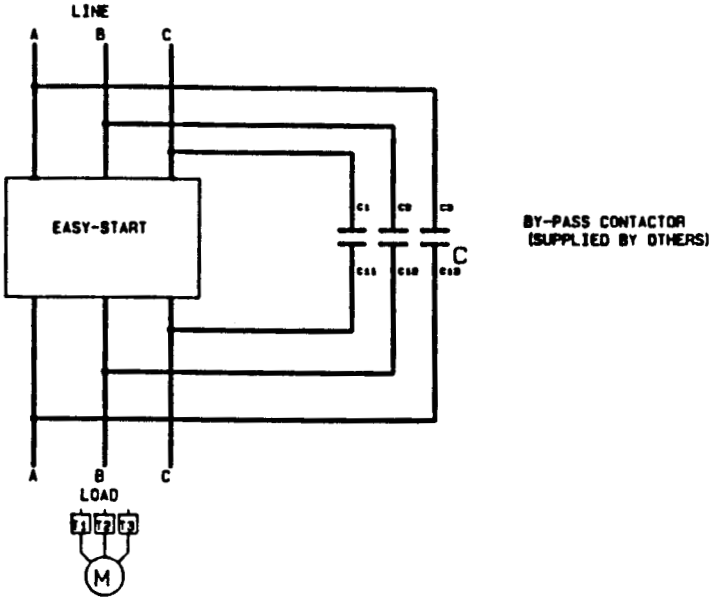
- Current vs. time ratings.
- Option schematics.
- Trip point settings and trip time curves.
- Connection diagrams.
- Component layouts.
- Dimension of option boards.



NEMA-1 Current Vs. Time Ratings
Figure 4-1



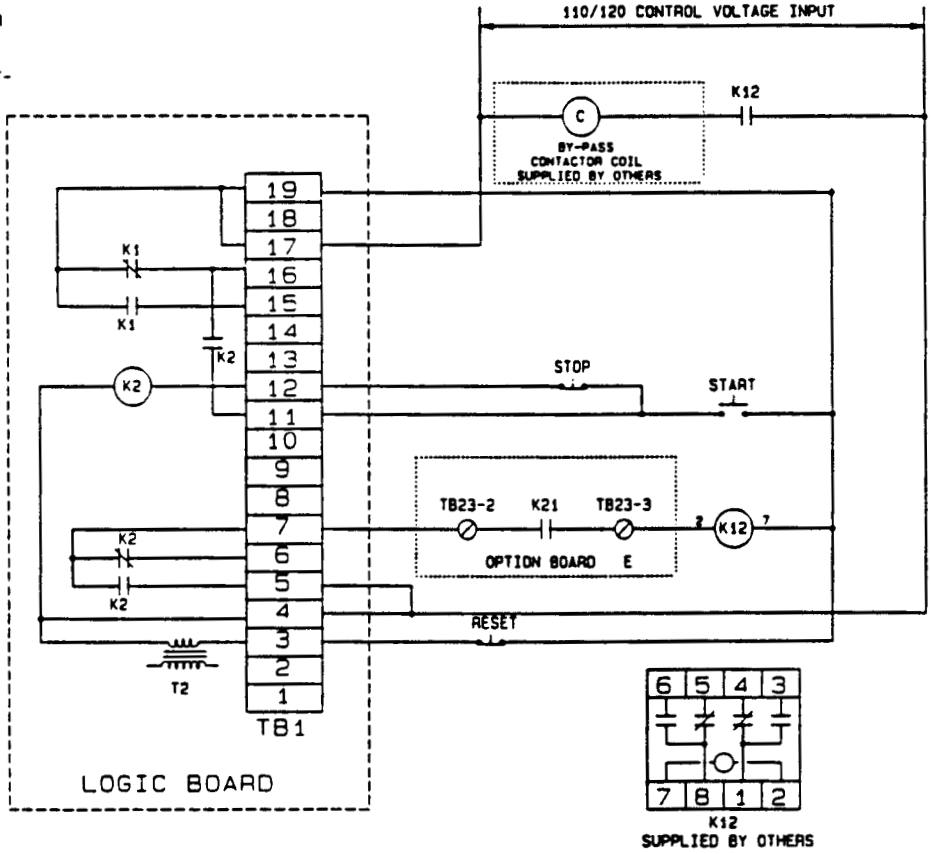
NEMA-12 Current Vs. Time Ratings
Figure 4-2



FILENAME: OPTBYPS1
9-21-98

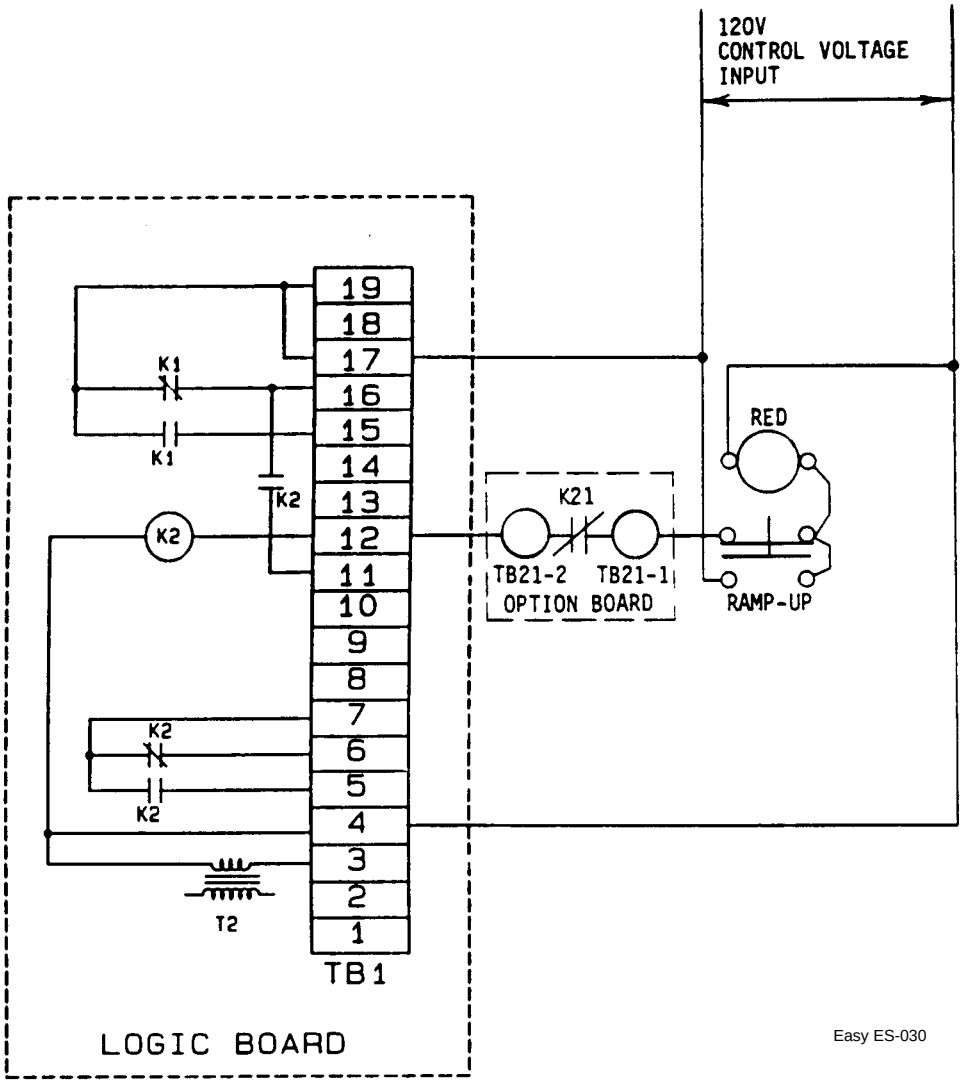
NOTES:
1. THIS DRAWING SHOWS THE BY-PASS CONTACTOR CONTROL WIRING USING OPTION BOARD "E"
2. OPTION BOARD "E" CONTAINS EXTENDED START-TIME AND END OF RAMP-UP.
3. END OF RAMP-UP RELAY K21 IS USED FOR BY-PASS CONTACTOR CONTROL THROUGH INTERFACE RELAY K12.
4. TB23 IS LOCATED ON OPTION BOARD "E"
5. K12 CAN BE MOUNTED ON THE DIN RAIL ON THE BACK PANEL: 2-7 COIL
   1-3 N.O. 1-4 N.C.
   8-5 N.C. 8-6 N.O.
   CONTACT RATINGS: 10 AMP 120VAC
   WESTINGHOUSE STYLE HA2P120AC
6. IMPORTANT:
   THE CONTROL POWER TRANSFORMER MUST BE SIZED TO HANDLE THE BY-PASS CONTACTOR COIL CURRENT:

CONSULT EASY-START INSTALLATION MANUAL NO. 9085-8650 FOR ADDITIONAL INFORMATION ON CONTROL WIRING AND SPECIFICATIONS.

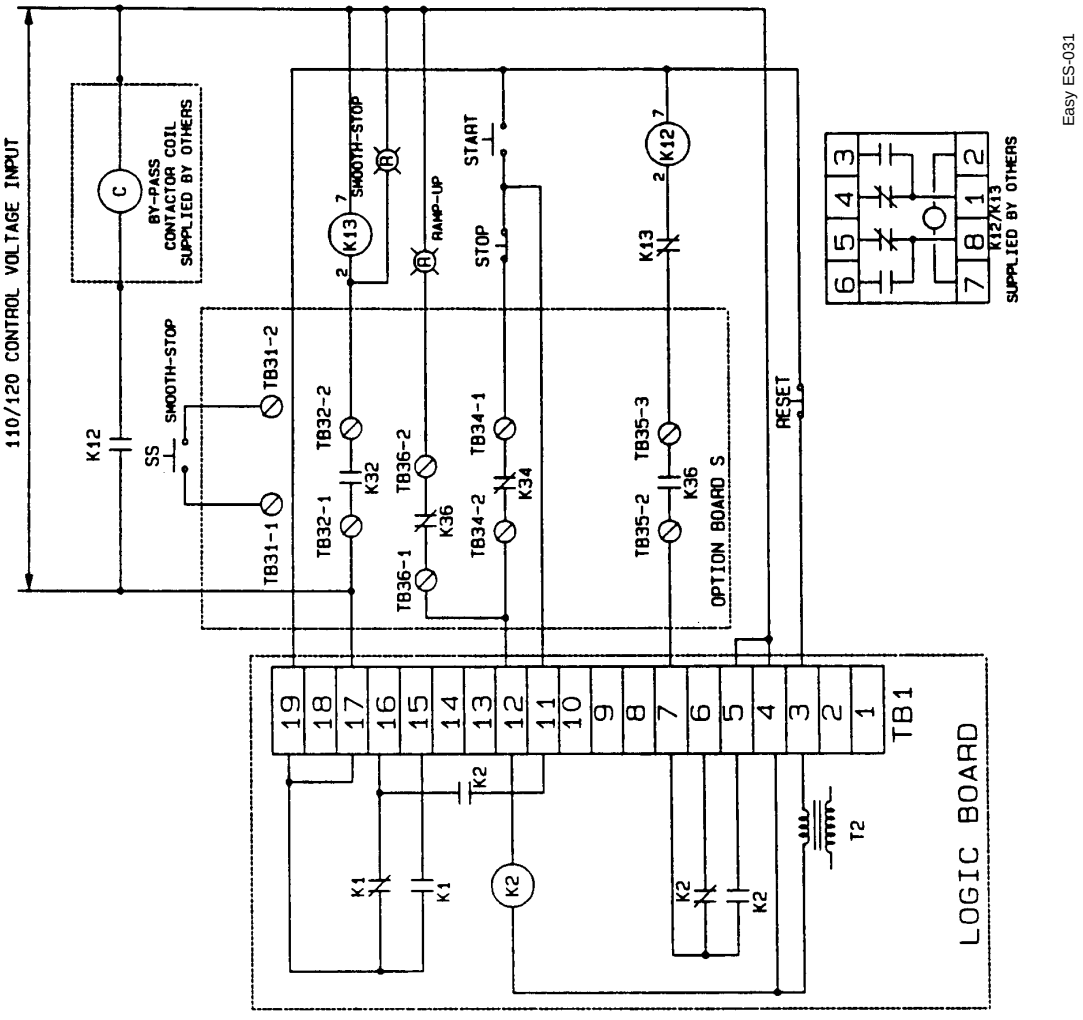


Easy ES-029

Extended Start Time with By-Pass Contactor
Figure 4-3



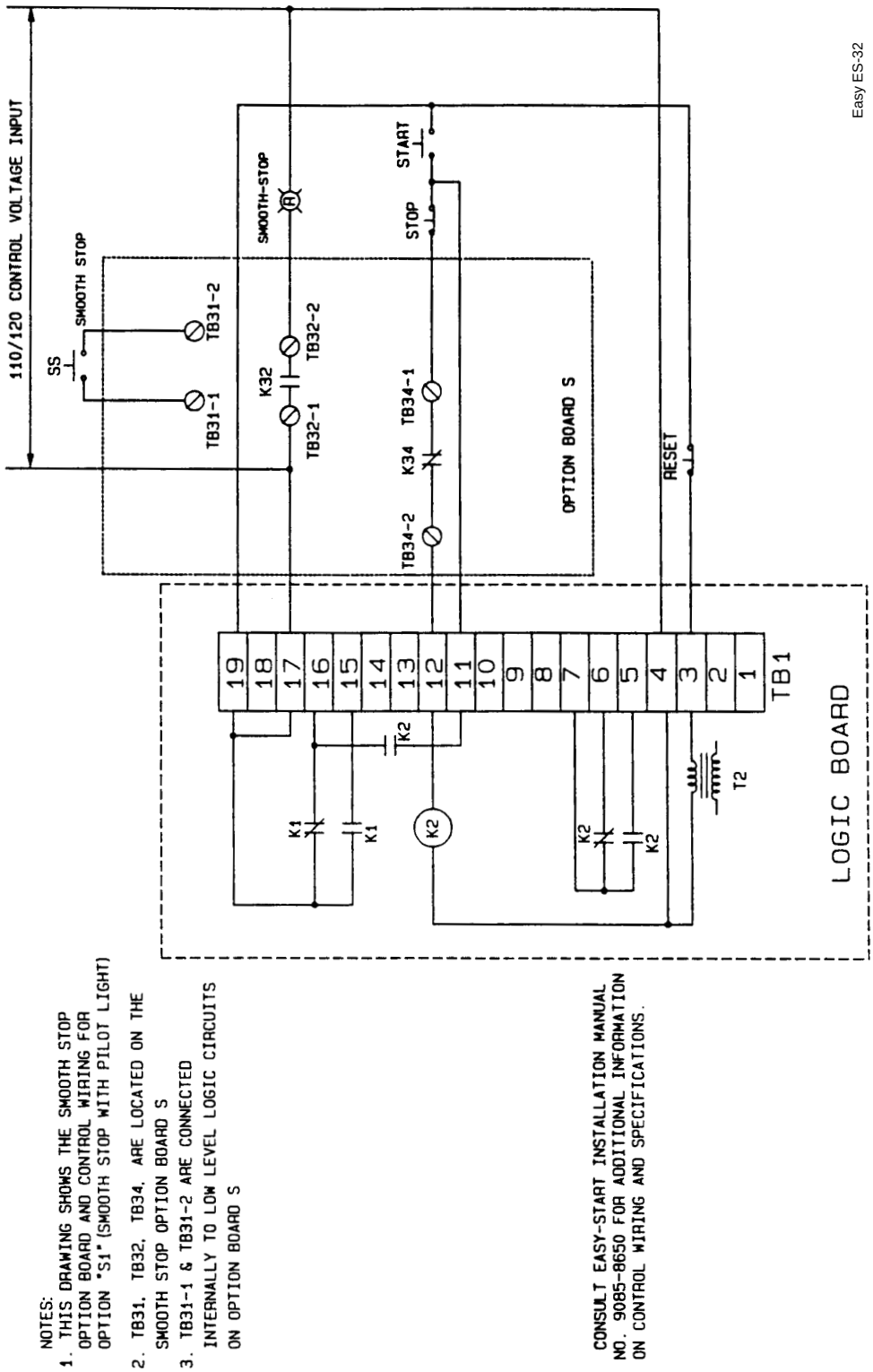
Option E1 - Extended Start Time with Ramp-Up Door Light
Figure 4-4



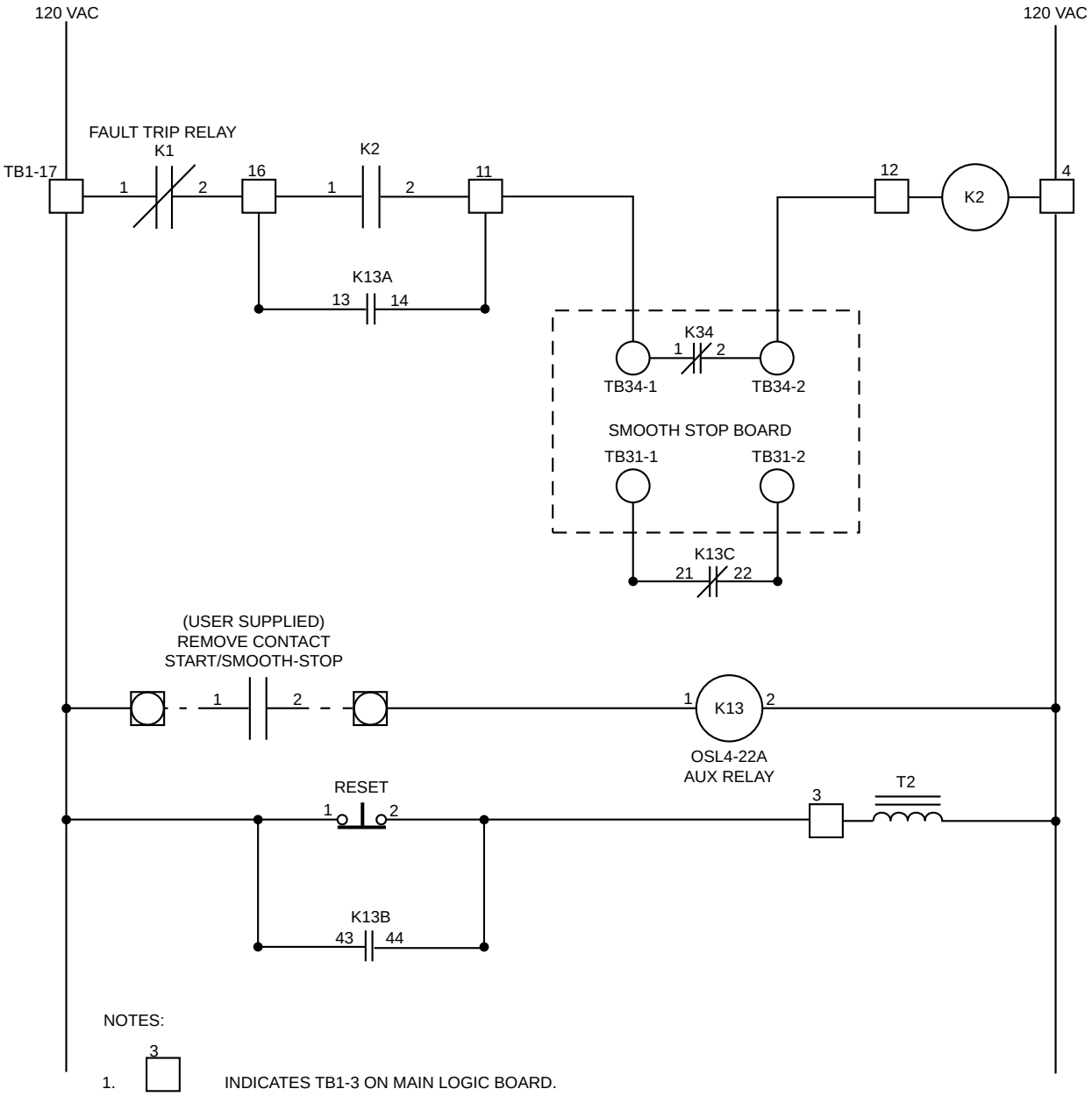
NOTES:
1. THIS DRAWING SHOWS THE SMOOTH STOP OPTION BOARD "S" AND ITS FUNCTIONS:
   OPTION S: SMOOTH STOP, NO PILOT LIGHTS
   OPTION S1: SMOOTH STOP WITH PILOT LIGHT
   OPTION S2: SMOOTH STOP WITH PILOT LIGHT AND 2ND PILOT LIGHT FOR RAMP-UP.
2. THE OPTION BOARD S CONTAINS THE FOLLOWING RELAYS AND TERMINAL BLOCKS:
   K32: TB32-1, TB32-2 CLOSES DURING SMOOTH STOP
   K34: TB33-1, TB33-2, TB33-3 FORM-C
   TB34-1, TB34-2, TB34-3 FORM-C
   CHANGES STATE AT END OF SMOOTH STOP
   K36: TB35-1, TB35-2, TB35-3 FORM-C
   TB36-1, TB36-2, TB36-3 FORM-C
   CHANGES STATE AT END OF RAMP-UP
   RELAY CONTACT RATINGS: 1 AMP 120 VAC
3. APPLICATION NOTE:
   OPTION BOARD S CAN BE USED TO CONTROL A BY-PASS CONTACTOR THROUGH INTERFACE RELAYS K12 AND K13. (SUPPLIED BY OTHERS)
   RECOMMENDED RELAY: WESTINGHOUSE STYLE MA2P120AC
   2-7 COIL
   1-3 N.O. 1-4 N.C.
   8-5 N.C. 8-6 N.O.
   CONTACT RATINGS: 10 AMP 120 VAC
   THESE RELAYS CAN BE MOUNTED ON THE DIN RAIL ON THE BACK PANEL.

IMPORTANT:
THE CONTROL POWER TRANSFORMER MUST BE SIZED TO HANDLE THE BY-PASS CONTACTOR COIL CURRENT.

Smooth-Stop with By-Pass Contactor
Figure 4-5



Smooth-Stop "S-1" Option
Figure 4-6



NOTES:

1. 3 INDICATES TB1-3 ON MAIN LOGIC BOARD.

2. FOR SAFTEY REASONS. THE REMOTE STARTING CONTACT MUST BE OPENED BEFORE THE STARTER CAN BE RESET, AFTER A FAULT TRIP OCCURS.

3. ADDITIONAL COMPONENT NEEDED, AUX RELAY, MFGR PART NO. DSL4-22A
OLDSMAR PART NO.6711C90G30

4. FOR FUTURE INFORMATION REFER TO EASY-START INSTALLATION MANUAL 9085-8550

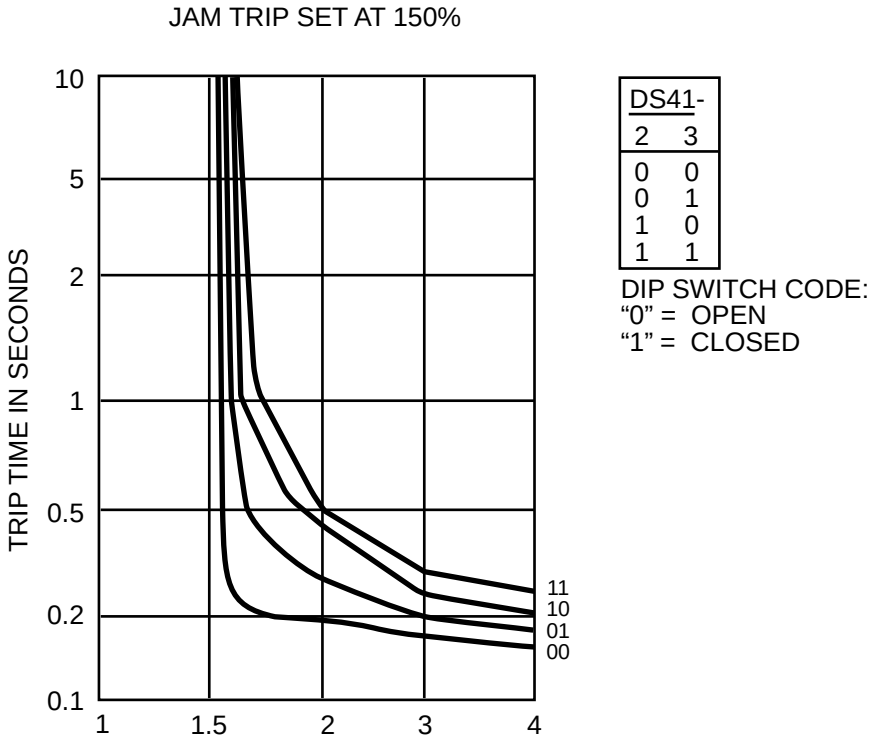
Easy ES-033

Smooth-Stop with Remote Maintained 2-Wire Contact
Figure 4-7

DS40-1234	% Trip
0000	100
0001	112
0010	125
0011	136
0100	152
0101	162
0110	172
0111	182
1000	194
1001	200
1010	212
1011	218
1100	230
1101	238
1110	245
1111	250

Easy ES-034

Jam DIP Switch Trip Point Settings
Figure 4-8



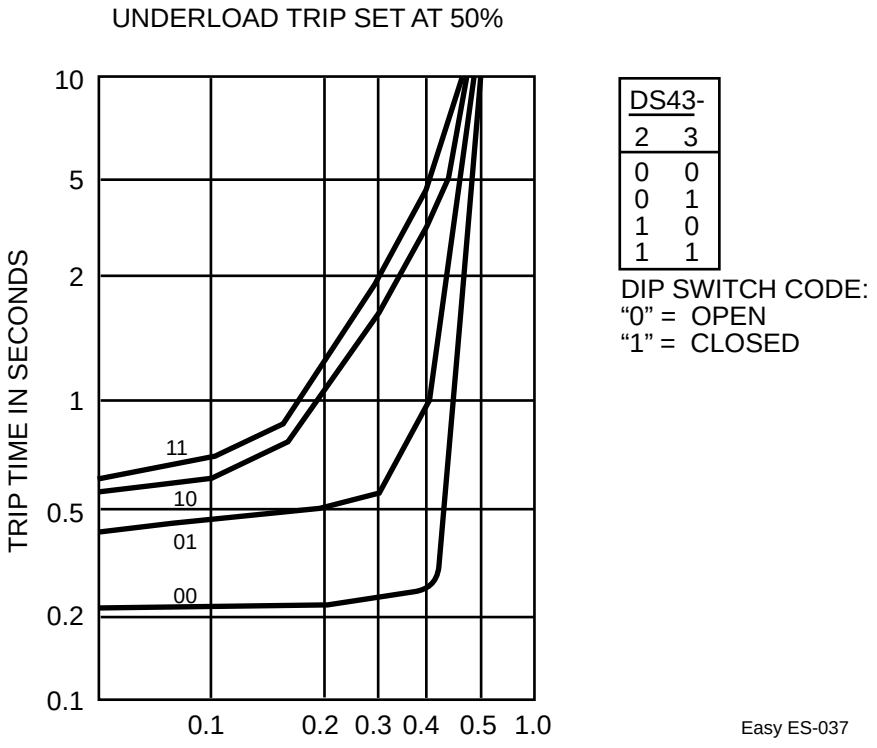
Easy ES-035

Jam Trip Time Curves
Figure 4-9

DS42-1234	% Trip
0000	25
0001	30
0010	35
0011	40
0100	45
0101	50
0110	53
0111	57
1000	61
1001	66
1010	71
1011	76
1100	80
1101	84
1110	87
1111	90

Easy ES-036

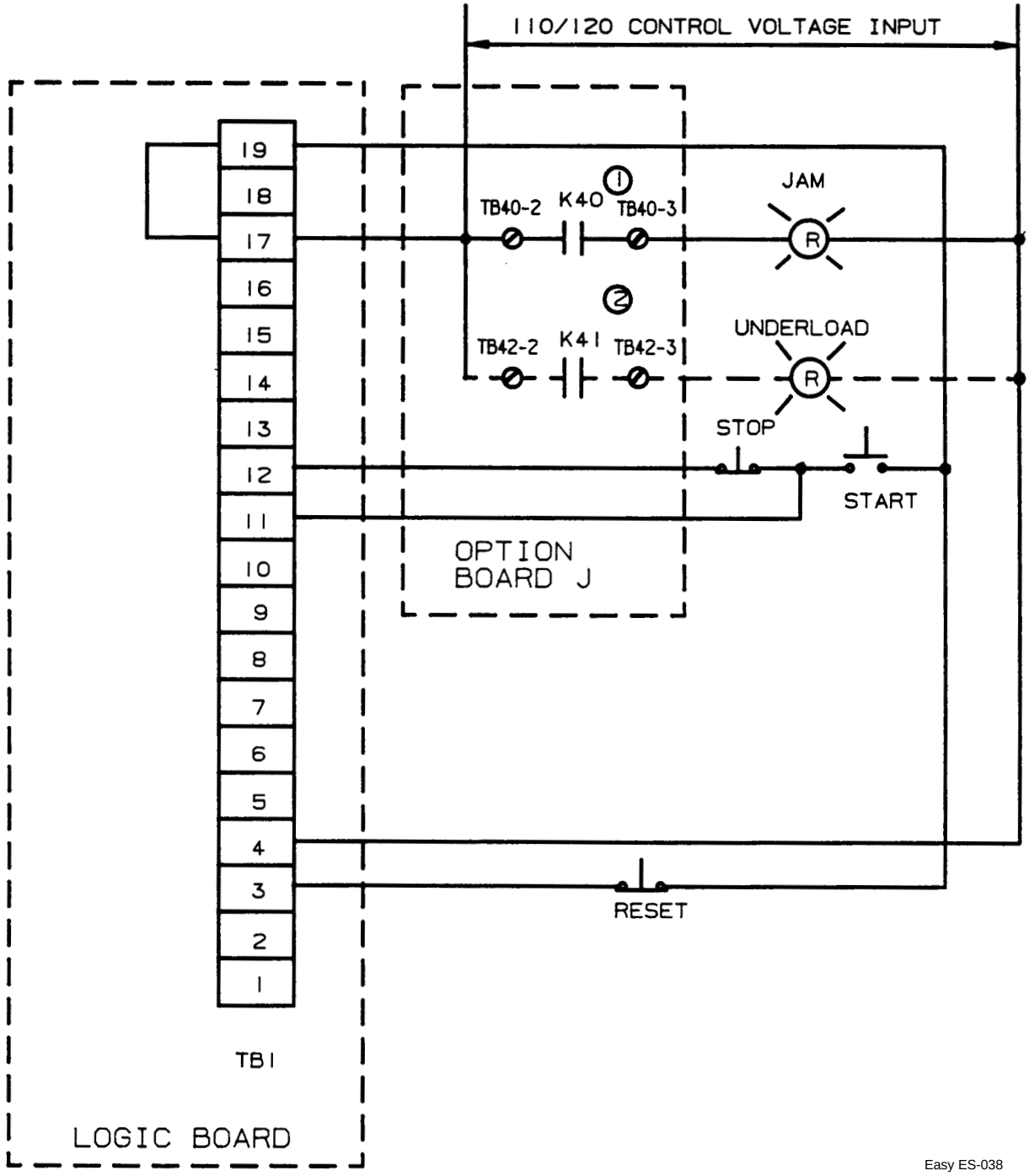
Underload DIP Switch Trip Point Settings Figure 4-10



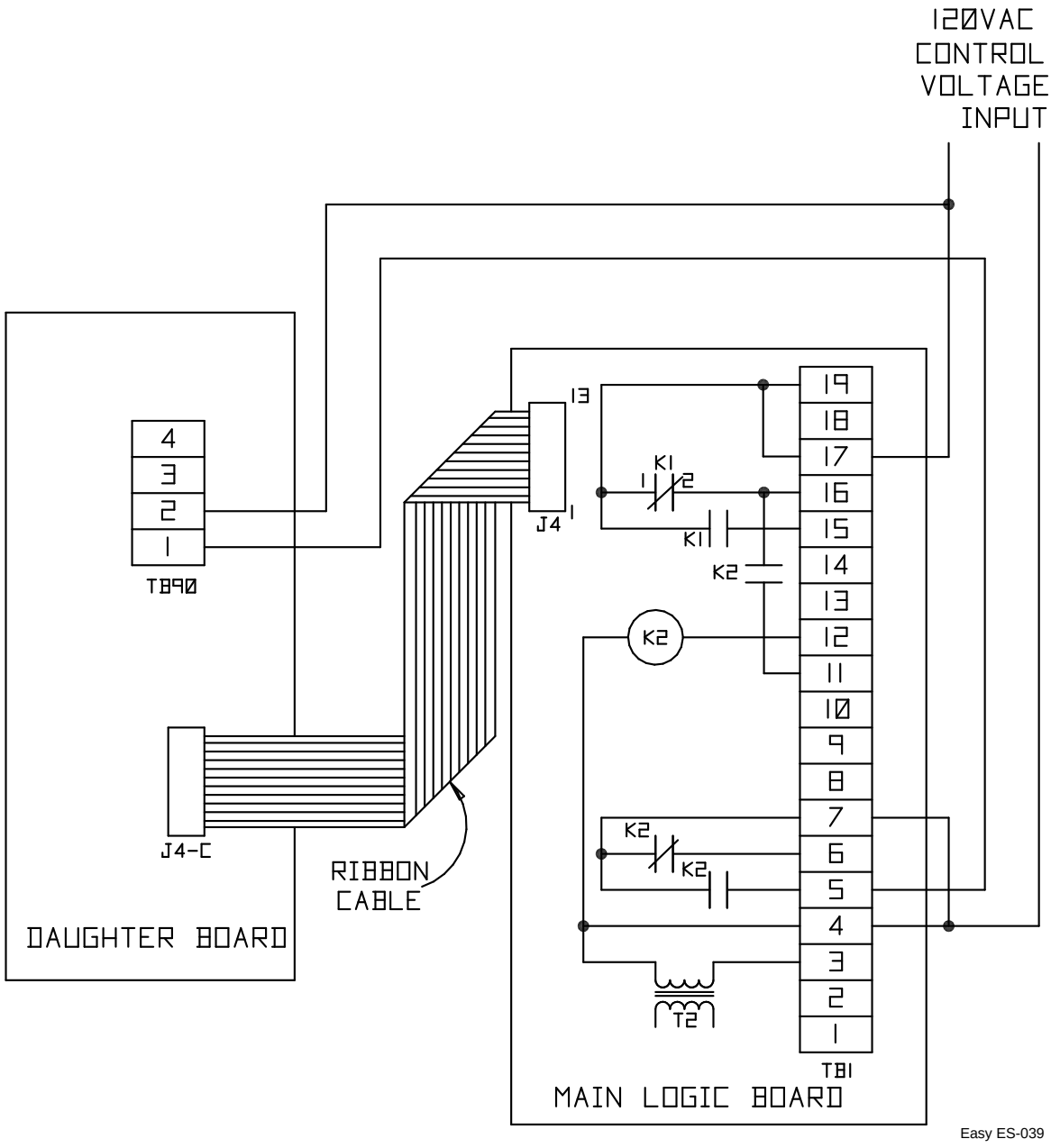
Underload Trip Time Curves Figure 4-11

NOTES:

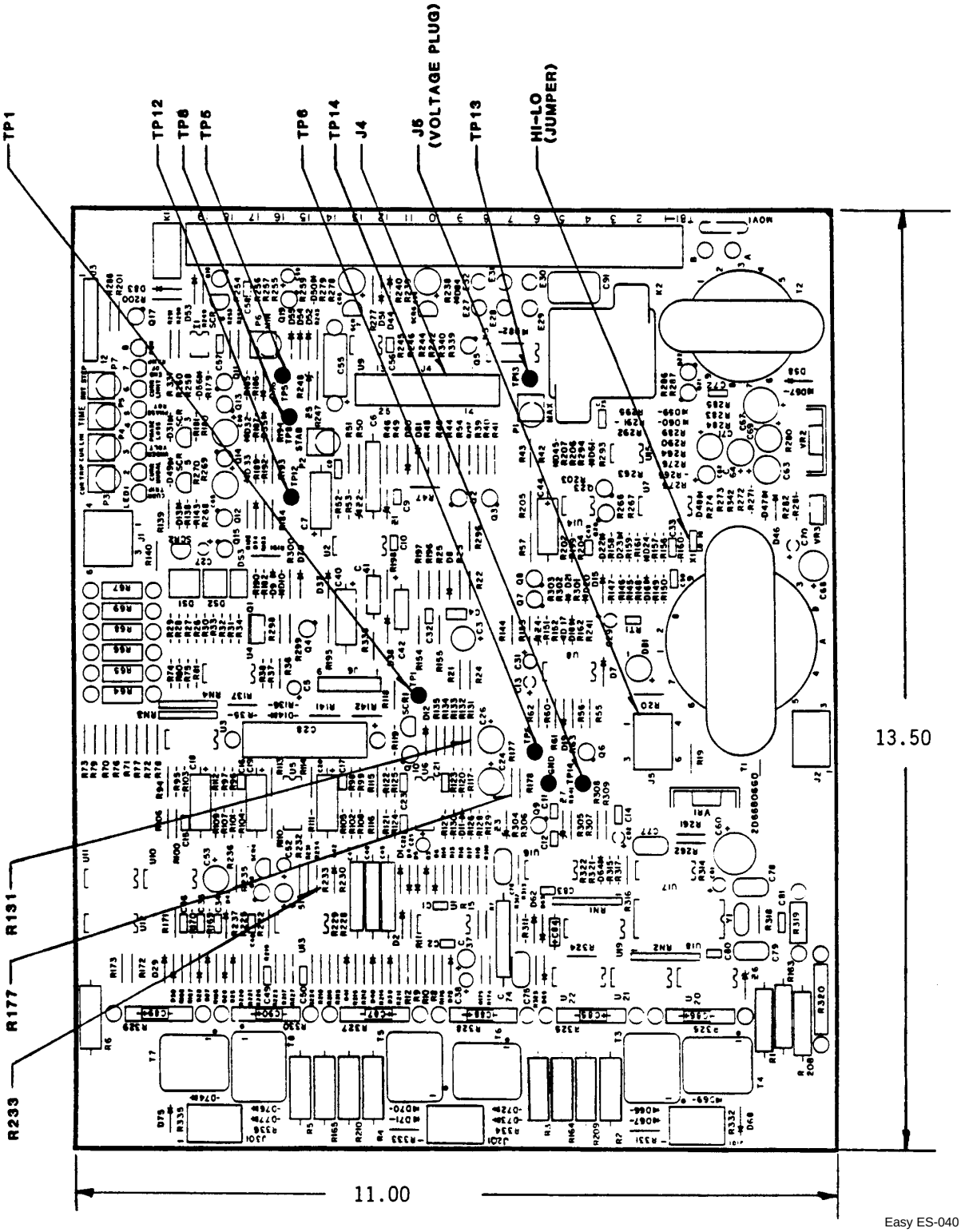
1. Option “J1” Jam Light
2. Option “J2” Underload Light



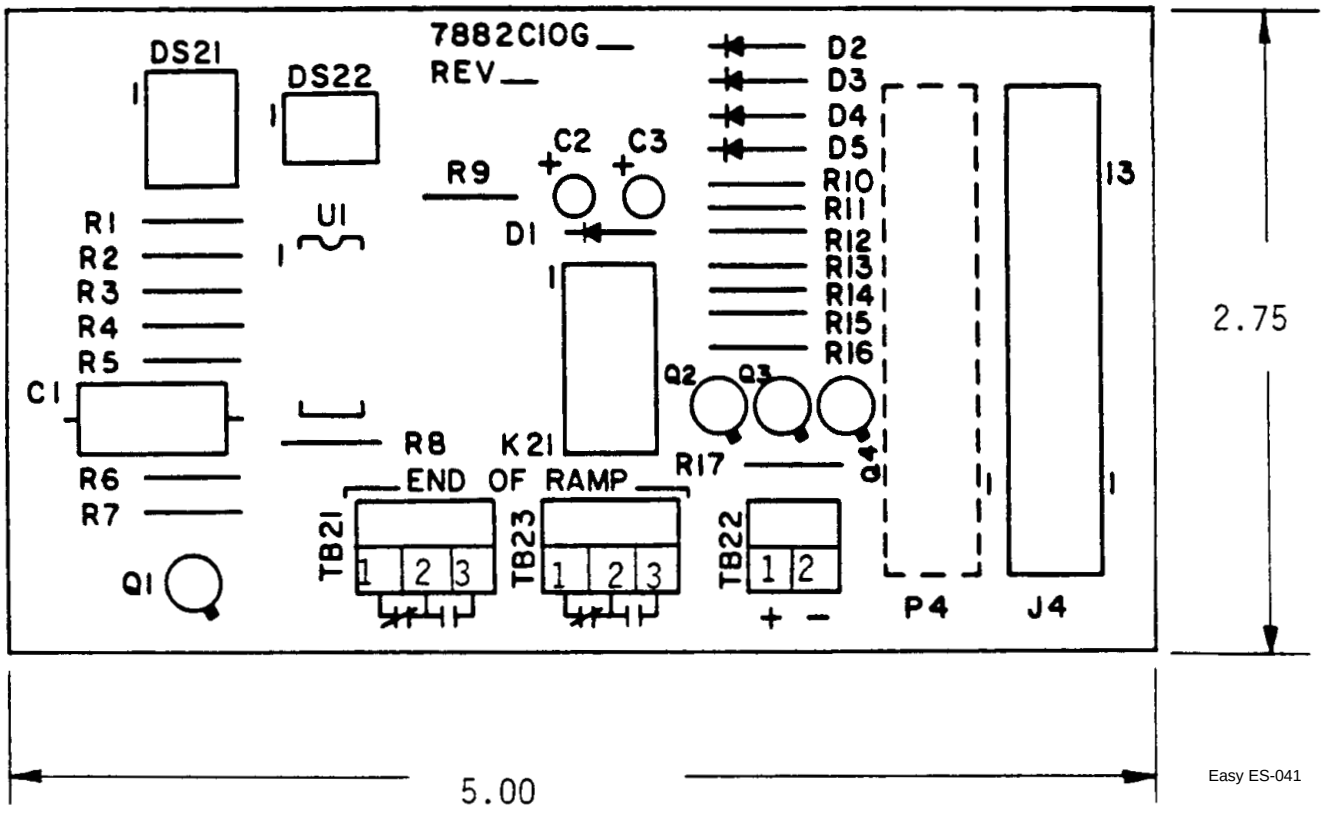
Options J1, J2 Jam-Underload with Red Trip Lights
Figure 4-12



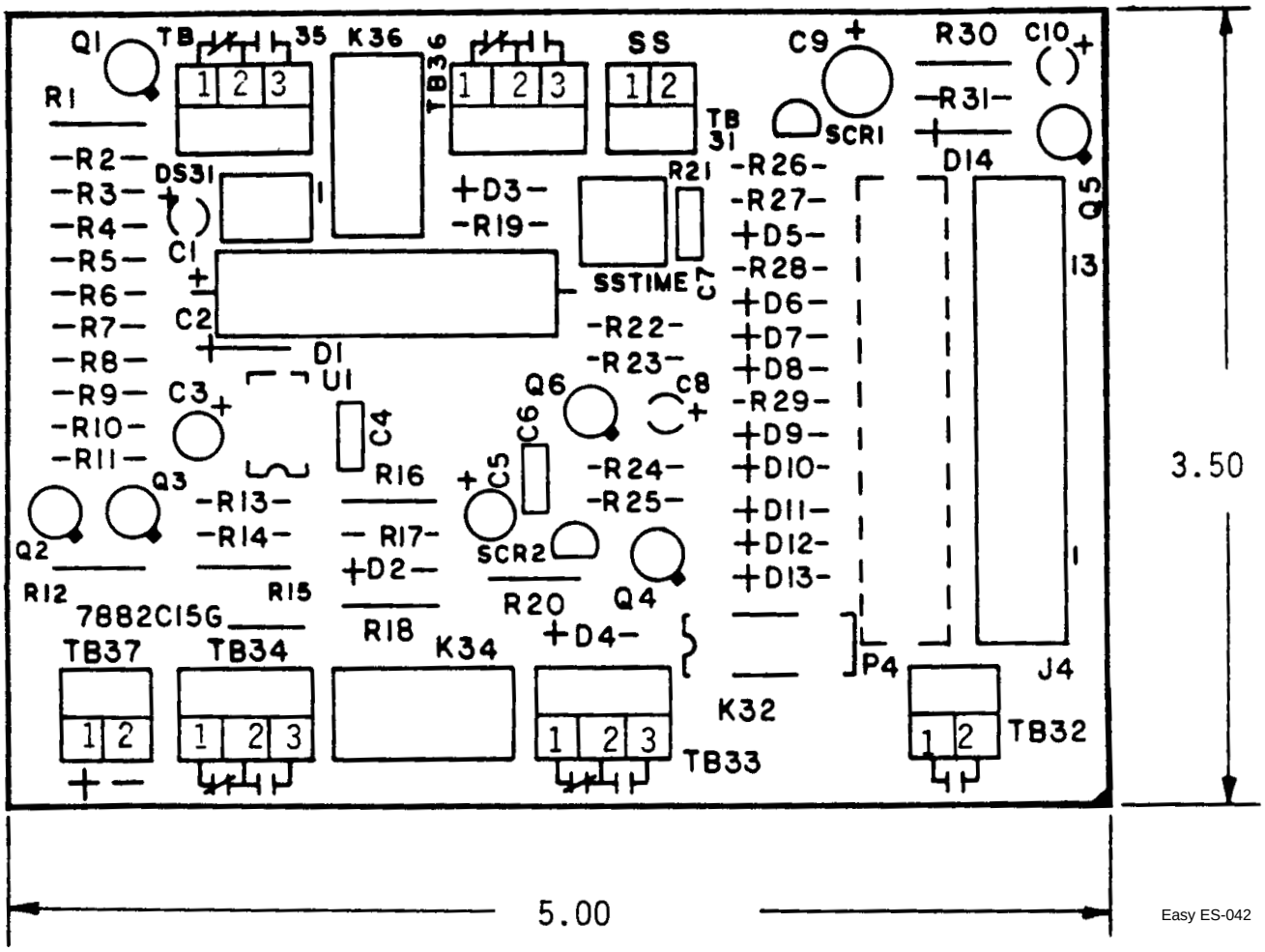
Daughter Board Connections
Figure 4-13



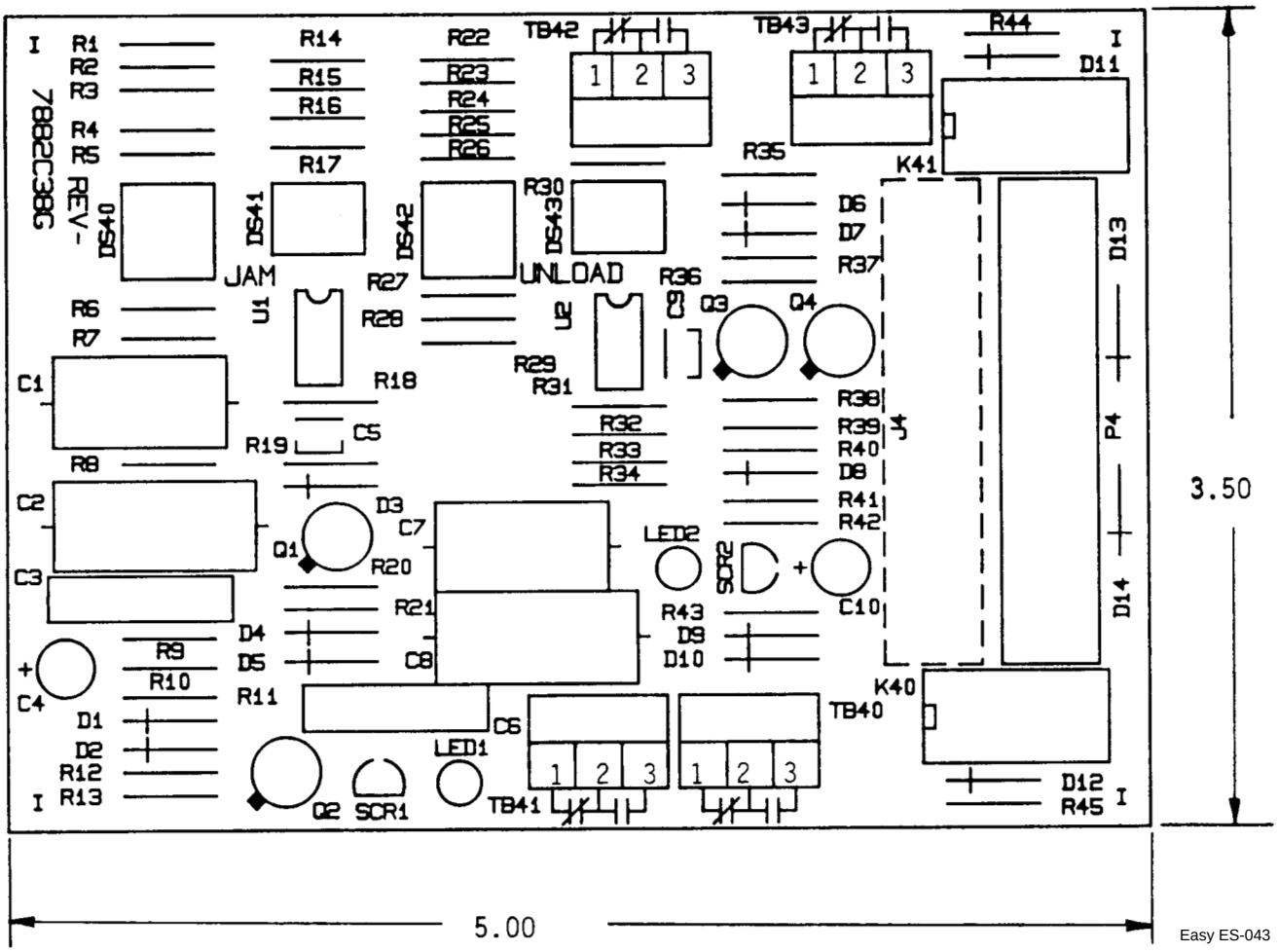
Printed Circuit Logic Board Component Layout
Figure 4-14



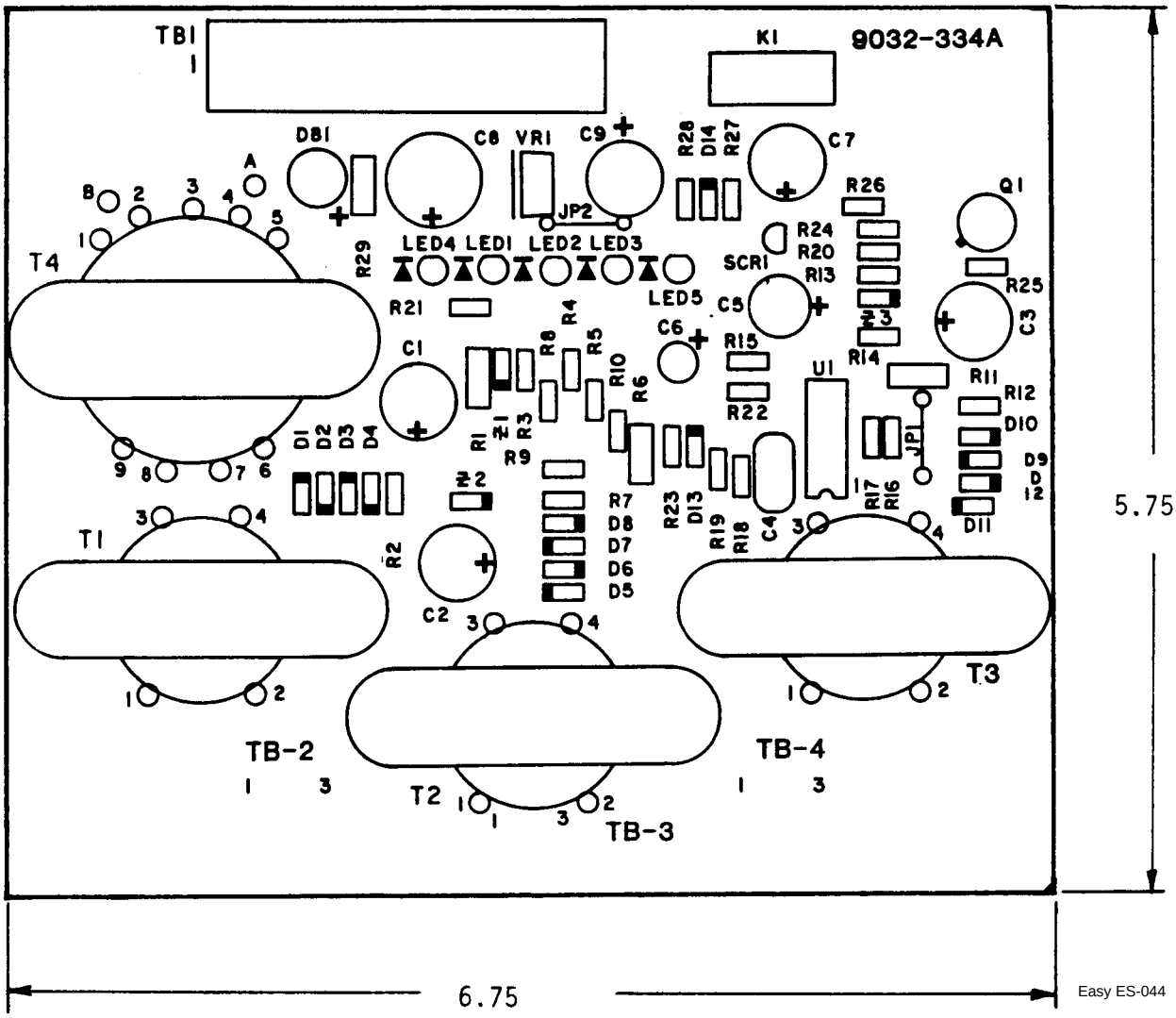
Option E - Printed Circuit Board Component Layout - Extended Start Time
Figure 4-15



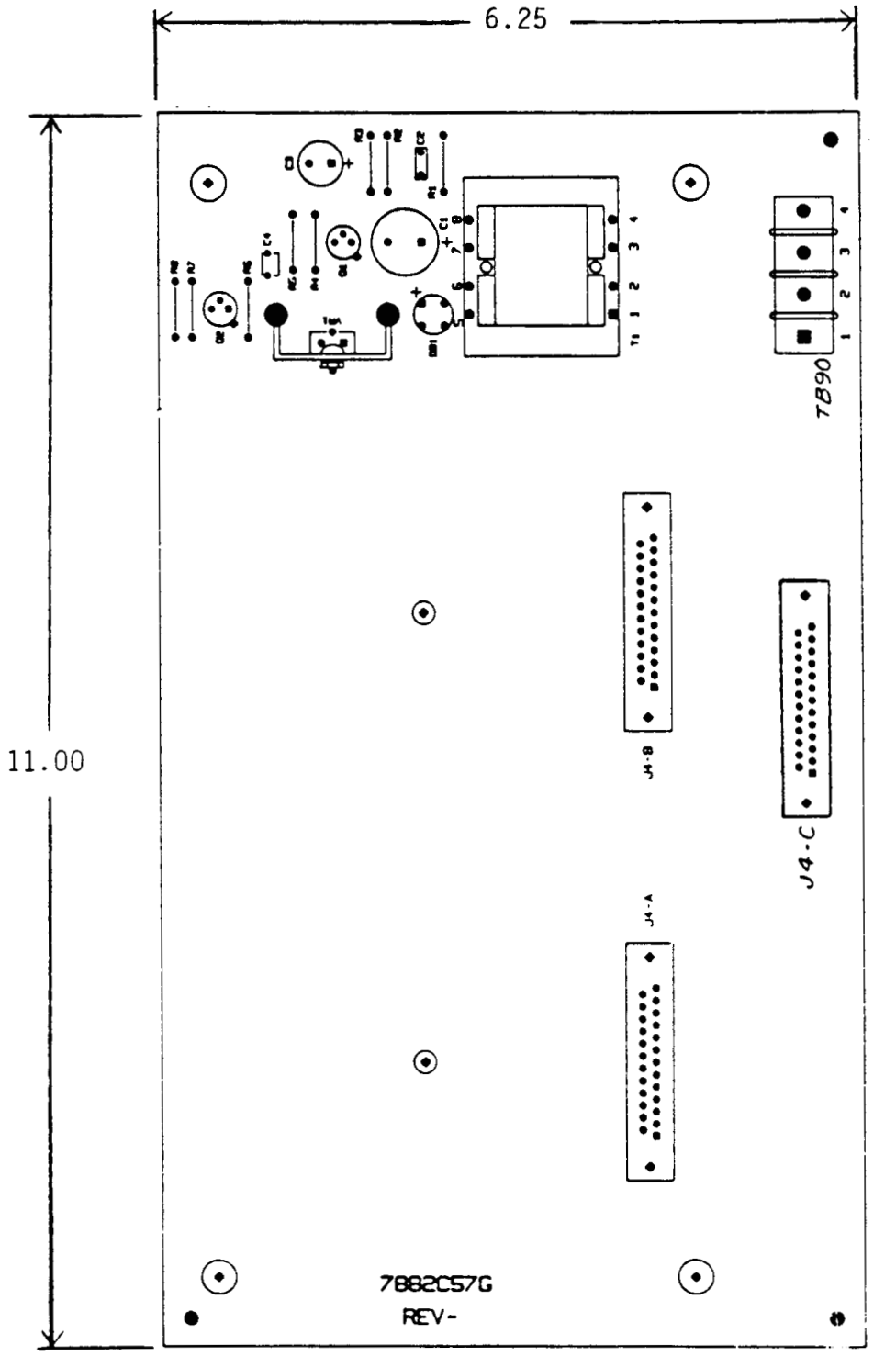
Option S - Printed Circuit Board Component Layout - Smooth-Stop
Figure 4-16



Option J - Printed Circuit Board Component Layout - Jam-Underload
Figure 4-17

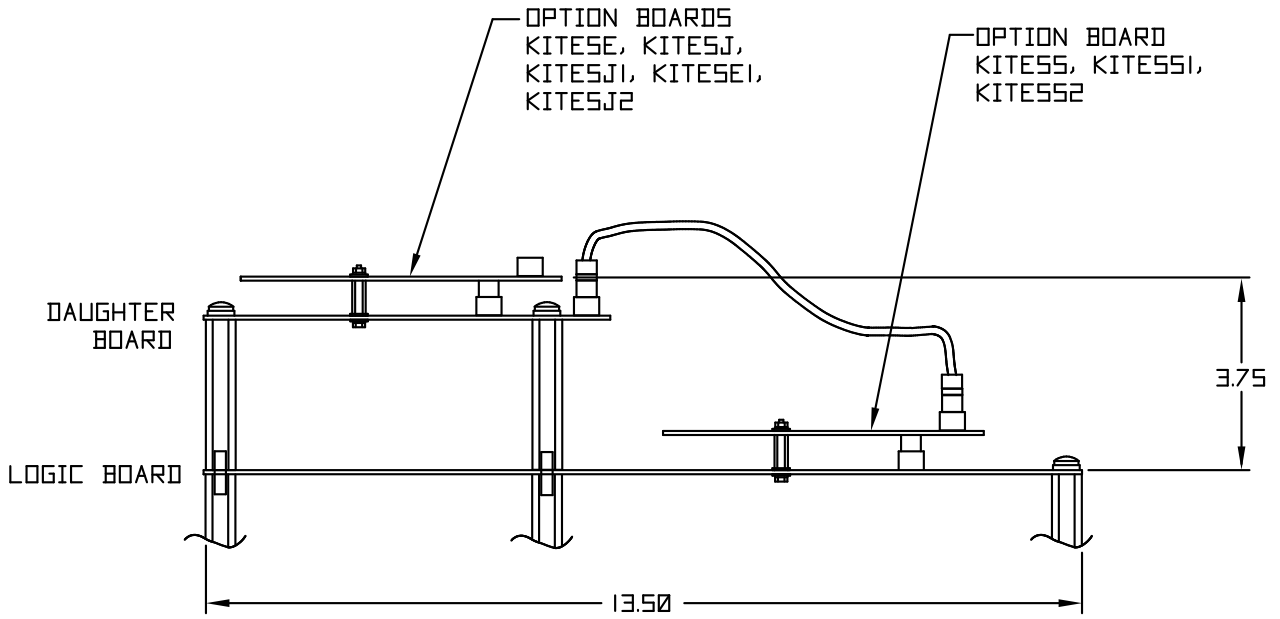


Option U - Printed Circuit Board Component Layout - Shorted SCR Detector
Figure 4-18

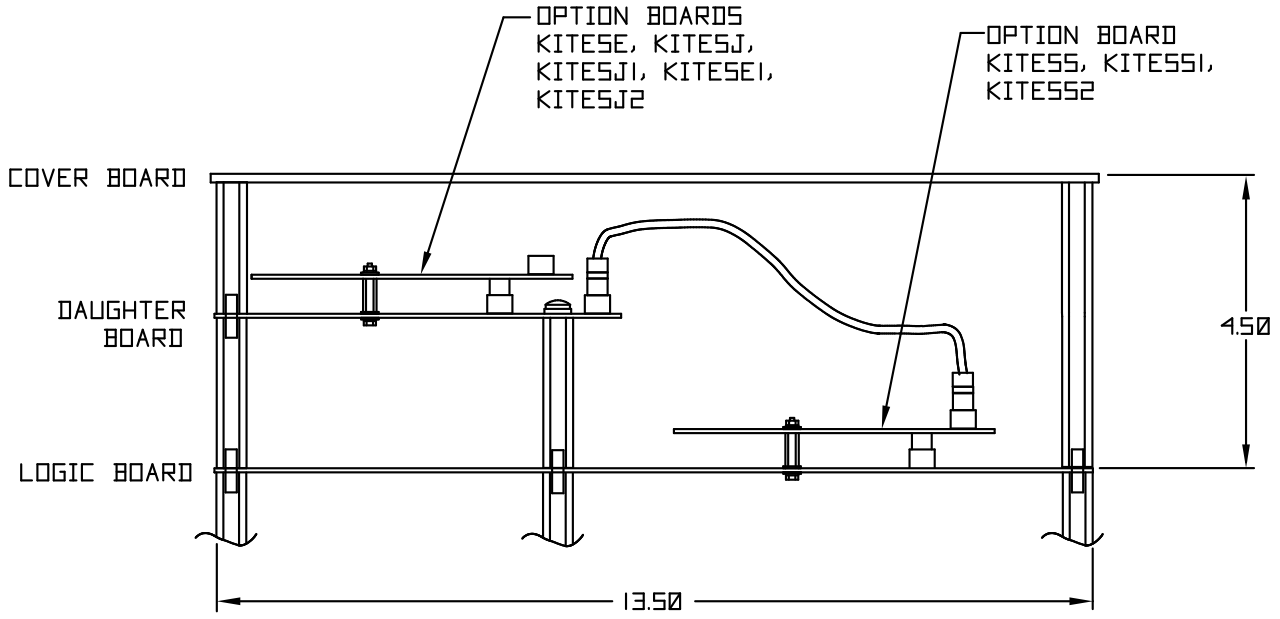


Easy ES-045

Option D - Printed Circuit Board Component Layout - Daughter Board
Figure 4-19



45, 70 & 120 AMPS



180 AMPS AND UP

NOTES:

1. DAUGHTER BOARD IS USED WHENEVER 2 OR MORE OF THE PLUG-IN OPTION BOARDS E, S, J ARE REQUIRED.

Easy ES-046

Dimensions for Logic Board, Daughter Board, Cover Board Assembly
Figure 4-20

SECTION 5
Troubleshooting

This section of your *Instruction Manual* describes what to do if your drive indicates there is a problem. After you review this section, you will understand:

- Troubleshooting Guide.
- SCR Diagnostic Tests.
- Renewal Parts List.

⚠ Caution

Make sure you read, understand and follow all of the Safety Statements in the Safety section of this manual before you troubleshoot your Motor Starter.

If further assistance is needed please feel free to contact Cutler-Hammer. Please have the following information ready:

G.O. No._____

Model No._____

Serial No._____

DIP Switch Setting_____

Troubleshooting Guide

A. Equipment Required

1. Multimeter Simpson 260 or Equivalent.
2. Clamp-On Ammeter.

⚠ Danger High Voltage

When making any measurements other than voltage or current readings, be sure that the line power is disconnected.

Never use a grounded voltmeter or oscilloscope to make measurements.

Do not use a megger for checking semiconductors.

B. Problem: The Motor Does Not Rotate

CHECK:

1. Measure the 3-phase line voltage.
2. Measure the 120 VAC control voltage at TB1-4 and TB1-17.
3. Check that all the connectors and plugs are securely fastened and snapped into place:
   - J-1 Current input from CT's.
   - J-2 Line voltage input.
   - J-3 Ribbon cable connector for LED status panel board.
   - J-4 Option connector (used for options).
   - J-5 Voltage plug (installed by user).
   - J-6 Option connector (used for options).
   - J-101 A-Phase SCR gate control leads.
   - J-201 B-Phase SCR gate control leads.
   - J-301 C-Phase SCR gate control leads.
4. Observe that all interwiring between the logic board, SCR's, heat sinks, and current transformers are intact and are not pinched.
5. Check the diagnostic LED's. These are located on the main logic board and also on the front door on standard factory supplied enclosures:

Front Door Status Panel:	**Logic Board:**
Run	Run
End of Ramp	End of Ramp
Current Limit	Curr Lim
Phase Rotation	Phase Rot
Phase Loss	Phase Loss
Under Voltage	Under Volt
Current Unbalance	Curr Unbal
Current Trip	Curr Trip
Overtemperature	

PHASE ROT LED

On initial installations and start-up, the "Phase Rot" LED may come on, indicating that the incoming line phase rotation is not A-B-C. This can be corrected by reversing any two lines that are connected to the line terminals of the Easy-Start ES.

The direction of motor rotation must be corrected at the load terminal side of the Easy-Start ES; if the motor is not running in its correct rotation, reverse any two motor leads.

PHASE LOSS LED

Check voltages at the line terminals.

Phase-A to Phase-B
Phase-B to Phase-C
Phase-C to Phase-A

Usually one or more of the other diagnostic LED's may come on if there is a phase loss; the reason is that the logic board is not receiving voltage from all three phases of the proper magnitude.

If all 3-phase voltages are present at the line terminals, and only the "Phase Rot" LED remains on, the phase rotation must be corrected as described in the preceding paragraph.

Troubleshooting Guide

UNDER VOLT LED

Check voltages at the line terminals.

The under-voltage circuit will activate if the line voltage is below 75% of nominal line voltage. (The under-voltage LED will not activate if the line voltage is disconnected from the starter, this is not treated as an under-voltage case.)

If the correct voltages are measured at the line terminals, check to see if the proper voltage plug is installed in the logic board. An example would be, if the 460V voltage plug is installed in the logic board and you are operating from a 230V supply line. Make sure the “HI” “LO” jumper is properly installed on the logic board. (See Table 3-13.)

Again, as stated in a previous paragraph, the under voltage LED may also come on if there is a phase loss.

If all voltages read properly, and none of the LED's are on, you are now ready to give the start command to the motor.

The **RUN** LED should come on, and stay on, whenever you give the start command. If it does not, check the 120 VAC control voltage at the terminal strip TB1. Read 120 VAC between TB1-12 and TB1-4 while holding the start button or switch, in the on position.

Visually check to see if the relay (K2) on the logic board is activating.

If the run LED does not come on, check the start, stop, reset, 120 VAC control circuit and all customer interlocks.

If the **RUN** LED comes on and the motor does not rotate; check the following:

- Measure the voltage at test point TP-6 on the logic board; it should be greater than 5 VDC.

- Check DIP switch DS1 and DS2 settings against motor FLA. Remember, DS2 is only activated if there is a connection made between TB1-2 and TB1-8 on the logic board.

- **Curr Lim** LED - The motor may be in a current limit; check the Curr Lim adjustment. Turn Curr Limit adjust CW. If the motor does not start, change the logic board.

When giving a start command, if a fault trip LED comes on, check the following:

- **Curr Trip** LED May indicate a wrong DIP switch DS1 and DS2 setting, or a short at the load or motor.

- **Curr Unbal** LED May indicate one of the following:

  a. Open gate-cathode lead connection, check the wires and also see if connectors are seated properly.

  b. Open motor lead.

  c. Open SCR gate (refer to SCR diagnostic tests Section 5-D.)

  d. Shorted SCR (refer to SCR diagnostic tests.)

  e. Open CT, or open lead in connector J-1.

Troubleshooting Guide

C. Problem: The motor rotates but does not reach full speed. The RUN LED is on; but the END OF RAMP LED does not come on.

Check:

1. DIP switch DS1 and DS2 settings against motor FLA.

2. Current limit adjustment may be set too low and will not provide enough starting torque; turn **Curr Lim** adjustment CW to increasing starting current. Measure the motor current with a clamp-on ammeter.

3. **Curr Trip** LED - If the current limit adjustment has been turned to its full CW position and the current trip LED comes on, before the motor reaches full speed, the Easy-Start ES may be undersized for the motor application. (See Over-Load Time-Current Characteristics Figure 3-1.) Try turning curr trip adjustment full CW. Try starting the motor in a reduced load condition; or if possible, remove the load from the motor completely and try for a successful start. This will help confirm that the Easy-Start ES is operating to its specifications. After a normal start has been completed, both the **RUN** LED and **END OF RAMP** LED will be on, and generally, for most normal applications, this will take less than 20 seconds. If the motor cannot be started, change the logic board.

D. SCR Diagnostic Tests

> **⚠ Caution**
>
> All power should be turned OFF when making ohmmeter measurements.

1. **Shorted SCR** - Measure from:

   Line-A to Load-A
   Line-B to Load-B
   Line-C to Load-C

   The resistance reading should be high or near infinity. A near zero reading indicates a shorted SCR. If any phase is shorted, replace the defective SCR.

   There are two basic types of SCR's used in Easy-Start ES:

   Isolated block SCR's containing 2 SCR's internally connected; the entire SCR block should be replaced in this case.

   Non-isolated hockey puk SCR's externally connected; in order to determine which SCR to replace, the copper strap or buss-bar connected between heatsinks, will have to be removed so that the SCR's can be measured individually.

2. **Open or Shorted Gate** - Remove the 3 gate plugs, J-101, J-201, J-301, from the logic board. The ohmmeter measurements should be made between pins 1 to 4 and pins 3 to 6 of each plug. The typical ohmic value should be between 5 and 200 ohms. If readings of near zero ohms, or near infinity, are measured, replace the SCR.

   Hockey puks should always be measured installed in pressure clamps, or false readings may result.

SCR Diagnostic Tests

E. Logic Board Digital Trigger Output:

> **⚠ Caution**
>
> Voltage is applied to the starter during this test. Exercise safe operation procedures.

Procedure:

1. Turn off all power to the Easy-Start ES.
2. Remove plugs J101, J201, and J301 from the logic board.
3. Place a short jumper across resistors R177 and R233. (This inhibits the phase rotation and phase loss trip circuits.)
4. Close DS3-2. This defeats the energy saver circuit.
5. Turn on the 120 VAC control voltage and three-phase power.
6. Energize the start or HOA switch to turn the starter on. (Make sure the **RUN** and **END OF RAMP** LED's are on when taking measurements. Turning the **TIME** pot full CCW will give a fast ramp-up for taking measurements; remember to return the **TIME** pot to the normal running condition when the measurements are completed.
7. Measure the 6 digital trigger SCR gate pulse outputs using a multimeter on the DC voltage range. These points are available on the connectors on the logic board.

	Pin Number Cathode (-)	Pin Number Gate (+)
J101	1	4
J101	3	6
J201	1	4
J201	3	6
J301	1	4
J301	3	6

The voltages should be approximately 0.7 volts DC.

Replace the logic board if the correct readings are not obtained.

Logic Board Voltage Measurements

The connector marked "J4" on the logic board can be used for options and test point voltage measurements. J4 pin number identification and typical test point voltage readings are shown on Table 5-1. These readings can also be taken directly on the logic board. The associated components and test points are listed under the column marked "Location." Whenever a test point terminal is supplied, example TP1, its location is also shown on Figure 4-14. There are two "Logic Common" test points on the board; they are TB1- 1 and a terminal marked "GND." One of these points must be used for the negative lead of the voltmeter.

If any of the above trigger output or test voltage measurements are not correct, the logic board should be replaced.

SCR Diagnostic Tests

SCR Service Procedures: (Hockey-Puk Type)

When changing SCR's in the field, it is best to remove the entire heat sink and lay it in a horizontal position. However, if this is not convenient, the following procedure can be used:

1. Remove the printed circuit logic board.

2. Remove the line power cable.

3. Remove the power strap between the two short heat sinks.

4. Loosen the two bolts (or nuts) on the pressure clamp until there is enough clearance between the two heat sinks to remove the SCR.

5. Remove the SCR.

6. Before installing the new SCR the old thermal compound should be removed from the heat sink and the mating surfaces should be inspected for burrs or voids. If it is necessary, use an extra fine grit emery cloth to smooth the mating heatsink surfaces. Coat the surfaces of the SCR with a thin coat of thermal compound (Alcoa-2 or an equivalent electrical joint compound). Wipe off the excess compound.

   Notice - Use sparingly - Apply only a thin coat of compound.

7. Place the SCR against the side of the sink that has the locating pin and make sure it engages and is seated properly. Place the other half of the heat sink against the SCR, and holding the assembly together, tighten the nuts on the compression clamp equally until they are finger tight. Check that the same number of threads are visible on both clamp studs.

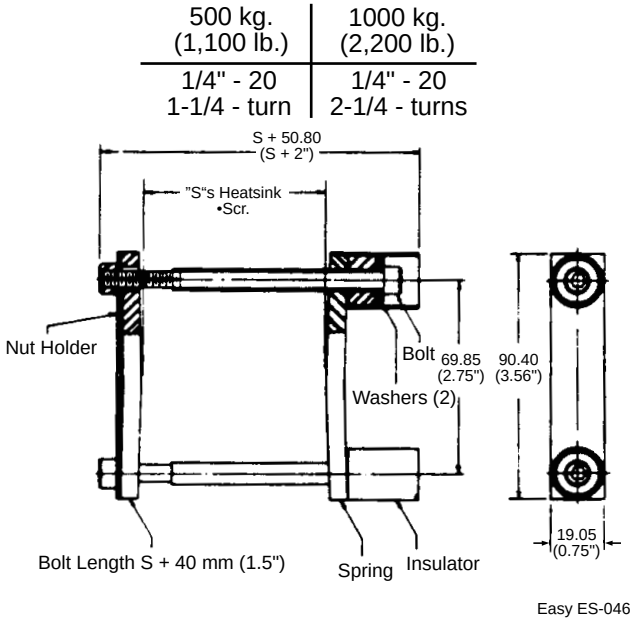
8. Tighten both nuts alternately in quarter-turn increments until the correct pressure is obtained. See Figures 5-1 and 5-2 for SCR clamps.

   SCR Mounting Clamp Pressure Can Be Determined by the Pole Face Dimension

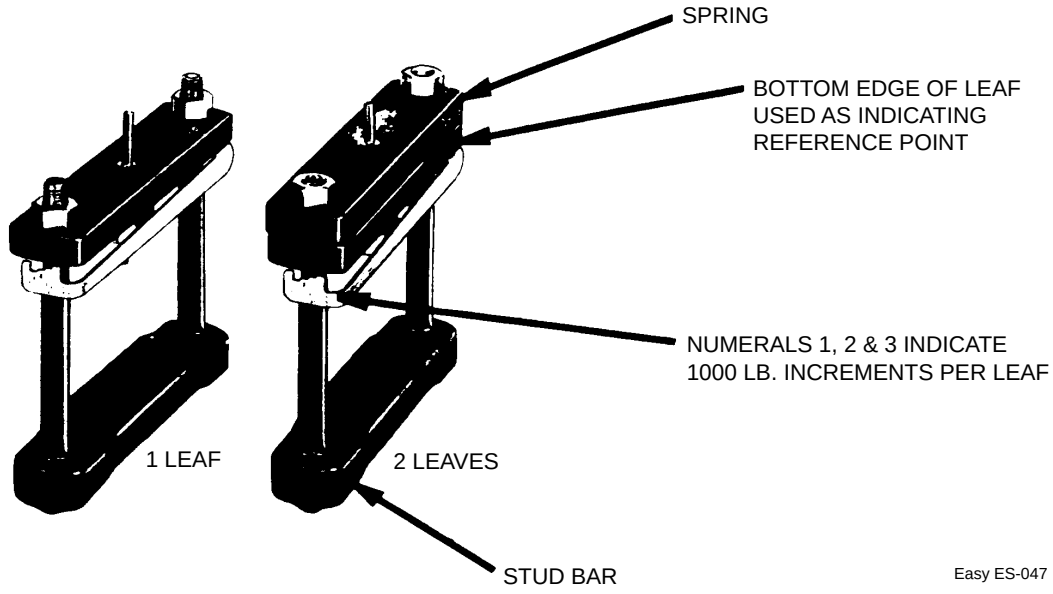
The Pole Face Is The Surface Area in Contact With The Sink

Typical Dimension of SCR Pole Face Dimension "A" Inches	Mounting Pressure Lbs.
0.75" - 1.0"	1200
1.15" - 1.34"	2000
1.75" - 1.85"	5000
2.5" - 3.0"	10000

SCR Diagnostic Tests



Typical SCR Clamp Used In ES180, ES260
Figure 5-1


SPRING
BOTTOM EDGE OF LEAF USED AS INDICATING REFERENCE POINT
NUMERALS 1, 2 & 3 INDICATE 1000 LB. INCREMENTS PER LEAF
1 LEAF
2 LEAVES
STUD BAR
Easy ES-047

Typical SCR Clamp Used In
ES180, ES250, ES260: 1 Leaf
ES360, ES500, ES560: 2 Leaves
Figure 5-2

SCR Diagnostic Tests

Pre-Start

- Review Cutler-Hammer recommended procedures for mounting “disc” power semiconductors (refer to W SCD Mounting Kit instructions).

- CAUTION: Deficient heat sink materials may creep or cold flow, relax, deflect with time and temperature under these high load forces. Stack assemblies must be thoroughly checked at design ratings.

- Spring load bar epoxy insulation coating is rated at 130°C NEMA B, 5000V RMS. Maximum sink temperature is restricted to 90°C maximum because of the high load forces used in clamping (high current) power semiconductors.

Stack Pre-Assembly

Step 1: Assemble sink-device clamp parts (reference clamp drawing, Figure 5-1).

Notice - It is recommended that a lubricant be used on the clamp bolt threads. ***Never-Seez, Anti-Seize lubricant compound, Type NSBT***, is suitable material for this purpose.

Stack Pre-Load

Step 2: If an inch-pound torque wrench is available, torque each clamp nut to 20 in-lbs.

Notice - This torque value is valid for well-lubricated threads only.

Should a torque wrench not be available, finger tighten each nut until snug; then turn each nut 1/4 turn with a wrench. Parts should now be held firmly.

Step 3: Check to make sure that load bars and heat sinks are parallel; equal lengths to thread may not show through each nut because of bolt length tolerances. (If load bars/sinks are not parallel, redo Step 2).

Stack Loading

Step 4: Insert a set of "vernier calipers" or other suitable depth gauging instrument through the hole in the uncoated bar. This gauge must be long enough to extend through the load bar and touch the hardened disc (approximately 2.30"). See Figure 5-4.

Step 5: Measure and record an initial reading of this distance “X”.

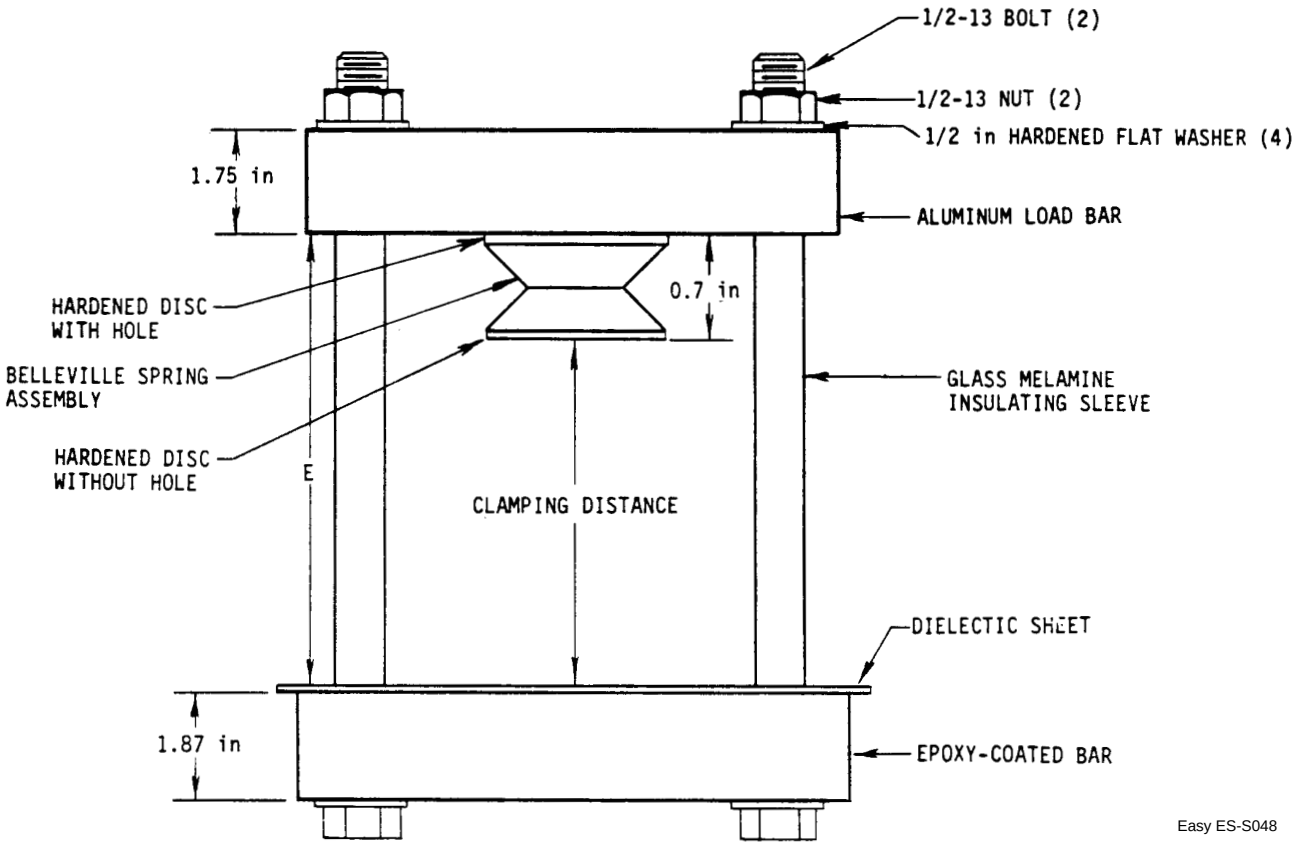
Step 6: Turn each nut 1/4 turn at a time until a relative displacement at “X” of 0.034" is obtained. This results in 10,000+ pounds force.

Stack Inspection

Step 7: Check load bars and heat sinks for parallelism. Apply a hi-temp paint over the clamp bolt/nut mating surfaces to fix their properly tightened original position (tamper indicator).

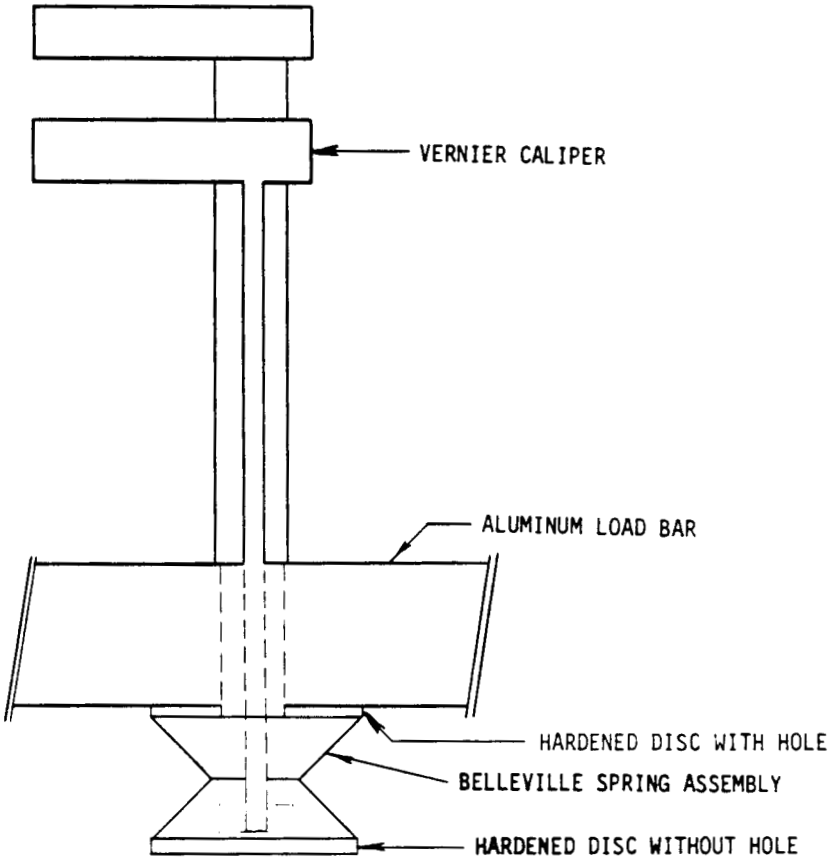
Step 8: Check stack assembly electrical values per device specifications.

SCR Diagnostic Tests



Assembly Sink-Device Clamp
Figure 5-3

SCR Diagnostic Tests



Stack Loading
Figure 5-4

SCR Diagnostic Tests

Changing Isolated Block SCR's:

The following procedure can be used for changing isolated block SCR's.

1. Remove the printed circuit logic board.

2. Remove the power and control connections from the SCR and identify the wires.

3. Remove the SCR block.

4. Before installing the new SCR block, the old thermal compound and any foreign matter should be removed from the heat sink mating surface. If necessary, use an extra fine grit emory cloth to smooth the heat sink surface. Coat the bottom surface of the SCR block with a thin coat of thermal compound (Alcoa-2 or an equivalent electrical joint compound). Wipe off the excess compound.

Notice - Use sparingly - Apply only a thin coat of compound.

5. Place the SCR block into position on the heat sink. Insert bolts and tighten them finger tight, or use a wrench until all the bolts are just snug. Tighten the bolts alternately in quarter-turn increments until the SCR block is tight. Keep equal pressure on all the mounting hardware. Visually inspect the SCR block to make sure it's lying flat on the heat sink.

6. Securely fasten the power and control wiring on the SCR block. Tug on the leads gently to make sure there are no loose connections. Check to make sure the SCR block is wired with the correct polarity.

SCR Diagnostic Tests

J4 PIN #	FUNCTION	LOCATION	CONDITION	TEST VOLTAGE
1	+10VDC	VR1-2	3-PH VOLTAGE ON	10V +.5
2	CURRENT SIG CURRENT SIG	TP1 TP1	START RUN/AT FULL LOAD	0 TO 4.5 VDC 0.90V + .04 VDC
3	TRIGGER VOLTS	TP6	RUN FULL LOAD RUN NO LOAD	6 TO 8 VDC 3 TO 3.5 VDC
4	CURR SIG CURR SIG	03 COLL 03 COLL	START RUN	0 0.1 TO .9 VDC
5	CURR TRIP V	U7-11	START RUN NO LOAD	0 TO 7 VDC 0 TO 1 VDC
6	SPARE			
7	END OF RAMP END OF RAMP	R253 R253	START RUN	0 10V +2 VDC
8	RAMP V RAMP V	Z5 CATHODE Z5 CATHODE	START RUN/STOP	0 TO 6.8 VDC 0
9	TRIP LINE	D44 CATHODE	FAULT TRIP	8V +2 VDC
10	LOAD SENSE LOAD SENSE	U2-1 U2-1	START RUN F LOAD ES-ON	0 -3.1 TO -3.7 VDC
11	INV INPUT	U2-6	START/RUN/STOP	INPUT ONLY
12	NON-INV INPUT NON-INV INPUT	TP5 TP5	START RUN	0 TO 2.5 VDC 1 V +.2 VDC
13	+12C +12C	TP8 TP8	START RUN/STOP	11V +1V 0
14	+12A	TB1-2	START/RUN/STOP	12V +.5
15	+12B +12B	TP12 TP12	START/RUN STOP	12V +.8 0
16	+12D	TP13	STOP	12V PULSE
17	STOP SIG	D45 ANODE	STOP	0-6V RAMP PULSE
18	LOCKOUT LOCKOUT	TP14 TP14	START/RUN STOP	+10V +.8V 0
19,20,21		SPARES		
22	AUX +12B			+12V +.9V
23	AUX +12A			+12V +1V
24	-12A	VR3-3	START/RUN/STOP	-12V +.5 VDC
25	LOGIC GROUND	TB1-1		

J4 Connector Test Voltages
Table 5-1

Renewal Parts List

The renewal parts are listed by an abbreviated Easy-Start ES model number, showing the current and voltage rating. The parts listed apply to both open panel and enclosed models.

Example:

ES180-4N The parts listed are for all standard ES180-4N models, open-panel or enclosed.

The complete part number of the renewal part requires the prefix shown at the top of each column. Please observe whether a hyphen is used or omitted.

Examples:

SCR For model ES560-4N is 9029-254AT

Logic Board For model ES560-4N is 2D66806G01

The number of parts required per model are as follows:

Logic Board: One required.

SCR's: Six required for non-isolated heat sink models. Three required for isolated heat sink models.

Stack Assembly: Three required.

Current Transformers: (Three required, 180 amp and above.) (One required below 180A.)

DV/DT Snubber: Three required.

MOV's: Three required except on models rated 750 amps and above; (six required).

Fan CPT: One required.

Here is a recommended spare parts list for a typical Easy-Start ES installation:

One Logic Board.
One Stack Assembly, or Two SCR's.
One set of MOV's.

On multiple Easy-Start ES installations, it is recommended that several parts of each are to be kept on hand, and the exact quantity to be determined by the user.

If no part number appears under the SCR column, then the SCR is not sold separately, and the stack assembly must be purchased.

The date code of your Easy-Start ES is on the name plate.

The date code of the logic board is on the logic board.

Protective Cover: Order part No. 2D66881H01

LED Status Printed Circuit Board Assembly: Order part No. 7881C82G01

Status View LED Panel: Order part No. 7881C83H01

Plug-In Relay K2 on logic board: Order part No. 0041-149A

Fan Control Relay K102 on panel: Order part No. 0041-119

Renewal Parts List

Fuses for Fan Control Power Transformers
(2 Required per Model):

208/230/460 and 380/415V Models up to 560 Amps: BUSS FNQ-2, 2 Amp

460/500/575V Models up to 560 Amps: BUSS KTK-1-1/2, 1-1/2 Amp

208/230/460 and 380/415V Models 500 and 750 Amps and above: BUSS FNQ5, 5 Amp

460/500/575V Models 500 and 750 Amps and above: BUSS KTK4, 4 Amp

Option Boards:	**Part Number:**
Extended Start Time:	7882C10G01
Jam/Underload:	7882C38G01
Smooth Stop/End of Ramp:	7882C15G01
Shorted SCR Detector:	9032334A

The following is a list of MOV's and their ratings:

MOV Number	**AC Volts**	**Joules**
0088219B	510 V	80
0088219A	600 V	80
0088102	490 V	300
0088103	600 V	300

Renewal Parts List

The following is a list of Easy-Start ES models, their SCR stack assemblies or back-to-back SCR's. The list indicates whether the DV/DT snubber or MOV components are included when the stack or back-to-back SCR's are ordered.

MODEL NO.	STACK ASS'Y	BACK-TO-BACK SCR's	DV/DT SNUBBER	MOV
ES045-4E	NO	9029-194	NO	NO
ES045-3E	NO	9029-194	NO	NO
ES045-5E	NO	9029-194AA	NO	NO
ES070-4E	NO	9029-438	NO	NO
ES070-3E	NO	9029-438	NO	NO
ES070-5E	NO	9029-438AA	NO	NO
ES120-4E	NO	9031-382H	NO	NO
ES120-3E	NO	9031-382H	NO	NO
ES120-5E	NO	9031-382J	NO	NO
ES180-4N	7881C65G01	NO	YES	YES
ES180-3N	7881C65G01	NO	YES	YES
ES180-5N	7881C65G02	NO	YES	YES
ES250-4E	7881C65G03	NO	YES	NO
ES250-3E	7881C65G03	NO	YES	NO
ES250-5E	7881C65G04	NO	YES	NO
ES260-4N	7881C65G03	NO	YES	NO
ES260-3N	7881C65G03	NO	YES	NO
ES260-5N	7881C65G04	NO	YES	NO
ES360-4E	7881C65G05	NO	YES	NO
ES360-3E	7881C65G05	NO	YES	NO
ES360-5E	7881C65G05	NO	YES	NO
ES500-4E	7881C65G05	NO	YES	NO
ES500-3E	7881C65G05	NO	YES	NO
ES500-5E	7881C65G05	NO	YES	NO
ES560-4N	7881C65G05	NO	YES	NO
ES560-3N	7881C65G05	NO	YES	NO
ES560-5N	7881C65G05	NO	YES	NO
ES750-4N	7882C28G01	NO	YES	NO
ES750-3N	7882C28G01	NO	YES	NO
ES750-5N	7882C28G01	NO	YES	NO

Renewal Parts List

MODEL #	LOGIC BOARD 2D66806	SCR 9029-	SCR STACK ASSY BACK-TO-BACK SCR's	C.T. 9010-	DV/DT SNUBBER 9071A17	MOV 0088-	FAN CPT 9010-	FAN 0034-
ES045-4E	G01	None	9029-194	457A	G02	219B	NONE	NONE
ES045-3E	G02	None	9029-194	457A	G02	219B	NONE	NONE
ES045-5E	G03	None	9029-194AA	457A	G04	219A	NONE	NONE
ES070-4E	G01	None	9029-438	457B	G02	219B	NONE	NONE
ES070-3E	G02	None	9029-438	457B	G02	219B	NONE	NONE
ES070-5E	G03	None	9029-438AA	457B	G02	219A	NONE	NONE
ES120-4E	G01	None	9031-382H	457C	G02	219B	NONE	NONE
ES120-3E	G02	None	9031-382H	457C	G02	219B	NONE	NONE
ES120-5E	G03	None	9031-382J	457C	G02	219A	NONE	NONE
ES180-4N	G01	260	7881C65G01	458A	G02	219B	NONE	NONE
ES180-3N	G02	260	7881C65G01	458A	G02	219B	NONE	NONE
ES180-5N	G03	260A	7881C65G02	458A	G04	219A	NONE	NONE
ES250-4E	G01	260	7881C65G03	458B	G01	102	392R	12
ES250-3E	G02	393	7881C65G03	458B	G01	102	392R	12
ES250-5E	G03	393A	7881C65G04	458B	G03	103	392R	12
ES260-4N	G01	260	7881C65G03	458E	G01	102	392R	12
ES260-3N	G02	260	7881C65G03	458E	G01	102	392R	12
ES260-5N	G03	260A	7881C65G04	458E	G03	103	392R	12
ES360-4E	G01	254AT	7881C65G05	458G	G03	103	392R	12
ES360-3E	G02	254AT	7881C65G05	458G	G03	103	392R	12
ES360-3E	G03	254AT	7881C65G05	458G	G03	103	392R	12
ES500-4E	G01	254AT	7881C65G05	458C	G03	103	392R	12
ES500-3E	G02	254AT	7881C65G05	458C	G03	103	392R	12
ES500-5E	G03	254AT	7881C65G05	458C	G03	103	392R	12
ES560-4N	G01	254AT	7881C65G05	458F	G03	103	392R	12
ES560-3N	G02	254AT	7881C65G05	458F	G03	103	392R	12
ES560-5N	G03	254AT	7881C65G05	458F	G03	103	392R	12
ES750-4N	G01	264A	7882C28G01	459A	G03	103	392T	106
ES750-3N	G02	264A	7882C28G01	459A	G03	103	392T	106
ES750-5N	G03	264A	7882C28G01	459A	G03	103	392T	106
ES950-4N	G01	264A	9031-377C	459B	G03	103	392T	106
ES950-3N	G02	264A	9031-377C	459B	G03	103	392T	106
ES950-5N	G03	264A	9031-377C	459B	G03	103	392T	106

Renewal Parts List

Voltage Plugs:

	Line Voltage	Plug Part Number	Voltage Stamped On Plug
208/230/460V Models:	208/230V	Plug 9028-460A	230
	460V	Plug 9028-460C	460
380/415V Models:	380V	Plug 9028-460G	380
	415V	Plug 9028-460H	415
460/500/575V Models:	460/500V	Plug 9028-460J	500
	575V	Plug 9028-460K	575

Cutler-Hammer Solid State Reduced Voltage Motor Starter Aftermarket Services

- **Technical/telephone support.**
- **Resident service engineers in major trading centers.**
- **Factory repair services.**
- **Warranty administration.**
- **Equipment modification and upgrading services.**
- **Training seminars.**

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